STORMWATER BETTER SITE DESIGN

1.4.1 Overview

1.4.1.1 Introduction

The first step in addressing stormwater management begins with the site planning and design process. Development projects can be designed to reduce their impact on watersheds when careful efforts are made to conserve natural areas, reduce impervious cover and better integrate stormwater treatment. By implementing a combination of these nonstructural approaches collectively known as *stormwater better site design practices*, it is possible to reduce the amount of runoff and pollutants that are generated from a site and provide for some nonstructural on-site treatment and control of runoff. The goals of better site design include:

- Managing stormwater (quantity and quality) as close to the point of origin as possible and minimizing collection and conveyance
- Preventing stormwater impacts rather than mitigating them
- Utilizing simple, nonstructural methods for stormwater management that are lower cost and lower maintenance than structural controls
- Creating a multifunctional landscape
- Using hydrology as a framework for site design

Better site design for stormwater management includes a number of site design techniques such as preserving natural features and resources, effectively laying out the site elements to reduce impact, reducing the amount of impervious surfaces, and utilizing natural features on the site for stormwater management. The aim is to reduce the environmental impact “footprint” of the site while retaining and enhancing the owner/developer’s purpose and vision for the site. Many of the better site design concepts can reduce the cost of infrastructure while maintaining or even increasing the value of the property.

Reduction of adverse stormwater runoff impacts through the use of better site design should be the first consideration of the design engineer. Operationally, economically, and aesthetically, the use of better site design practices offers significant benefits over treating and controlling runoff downstream. Therefore, all opportunities for using these methods should be explored and all options exhausted before considering structural stormwater controls.

The reduction in runoff and pollutants using better site design can reduce the required runoff peak and volumes that need to be conveyed and controlled on a site and, therefore, the size and cost of necessary drainage infrastructure and structural stormwater controls. In some cases, the use of better site design practices may eliminate the need for structural controls entirely. Hence, better site design concepts can be viewed as both a water quantity and water quality management tool.

Several of the site design practices described in this section provide a calculable reduction or site design “credit” which can be applied to the unified stormwater sizing criteria requirements. Subsection 1.4.4 will discuss these practices and provide examples of their application.

The use of stormwater better site design can also have a number of other ancillary benefits including:

- Reduced construction costs
- Increased property values
- More open space for recreation
- More pedestrian friendly neighborhoods
- Protection of sensitive forests, wetlands and habitats
- More aesthetically pleasing and naturally attractive landscape
- Easier compliance with wetland and other resource protection regulations

1.4.1.2 List of Stormwater Better Site Design Practices and Techniques

The stormwater better site design practices and techniques covered in this Manual are grouped into four categories and are listed below:

- **Conservation of Natural Features and Resources**
  - Preserve Undisturbed Natural Areas
  - Preserve Riparian Buffers
  - Avoid Floodplains
  - Avoid Steep Slopes
  - Minimize Siting on Porous or Erodible Soils
- **Lower Impact Site Design Techniques**
  - Fit Design to the Terrain
  - Locate Development in Less Sensitive Areas
  - Reduce Limits of Clearing and Grading
  - Utilize Open Space Development
  - Consider Creative Development Design
- **Reduction of Impervious Cover**
  - Reduce Roadway Lengths
  - Reduce Building Footprints
  - Reduce the Parking Footprint
  - Reduce Setbacks and Frontages
  - Use Fewer or Alternative Cul-de-Sacs
  - Create Parking Lot Stormwater "Islands"
- **Utilization of Natural Features for Stormwater Management**
  - Use Buffers and Undisturbed Areas
  - Use Natural Drainageways Instead of Storm Sewers
  - Use Vegetated Swale (restricted by lot size) Instead of Curb and Gutter
  - Drain Rooftop Runoff to Pervious Areas

More detail on each site design practice is provided in the Stormwater Better Site Design Practice Summary Sheets in subsection 1.4.2. These summaries provide the key benefits of each practice, examples and details on how to apply them in site design.

1.4.1.3 Using Stormwater Better Site Design Practices

Site design should be done in unison with the design and layout of stormwater infrastructure in attaining stormwater management goals. Figure 1.4.1-1 illustrates the stormwater better site design process that utilizes the four better site design categories.

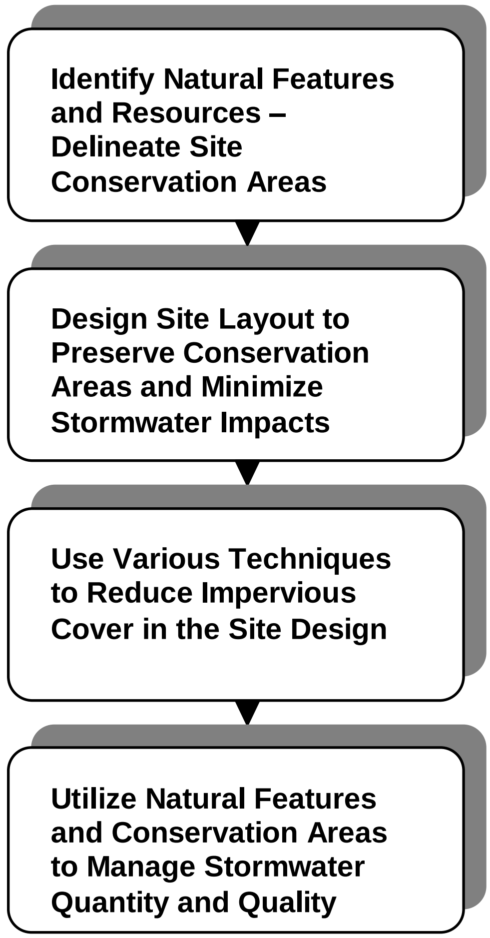


Figure 1.4.1-1 Stormwater Better Site Design Process

The first step in stormwater better site design involves identifying significant natural features and resources on a site such as undisturbed forest areas, stream buffers and steep slopes that should be preserved to retain some of the original hydrologic function of the site.

Next, the site layout is designed such that these conservation areas are preserved and the impact of the development is minimized. A number of techniques can then be used to reduce the overall imperviousness of the development site.

Finally, natural features and conservation areas can be utilized to serve stormwater quantity and quality management purposes.

1.4.2 Better Site Design Practices

1.4.2.1 Conservation of Natural Features and Resources

Conservation of natural features is integral to better site design. The first step in the better site design process is to identify and preserve the natural features and resources that can be used in the protection of water resources by reducing stormwater runoff, providing runoff storage, reducing flooding, preventing soil erosion, promoting infiltration, and removing stormwater pollutants. Some of the natural features that should be taken into account include:

- Areas of undisturbed vegetation
- Floodplains and riparian areas
- Ridgetops and steep slopes
- Natural drainage pathways
- Intermittent and perennial streams
- Wetlands / tidal marshes
- Aquifers and recharge areas
- Soils
- Shallow bedrock or high water table
- Other natural features or critical areas

Some of the ways used to conserve natural features and resources described over the next several pages include the following methods:

- Preserve Undisturbed Natural Areas
- Preserve Riparian Buffers
- Avoid Floodplains
- Avoid Steep Slopes
- Minimize Siting on Porous or Erodible Soils

Delineation of natural features is typically done through a comprehensive site analysis and inventory before any site layout design is performed (see Section 1.5). From this site analysis, a concept plan for a site can be prepared that provides for the conservation and protection of natural features. Figure 1.4.2-1 shows an example of the delineation of natural features on a base map of a development parcel.

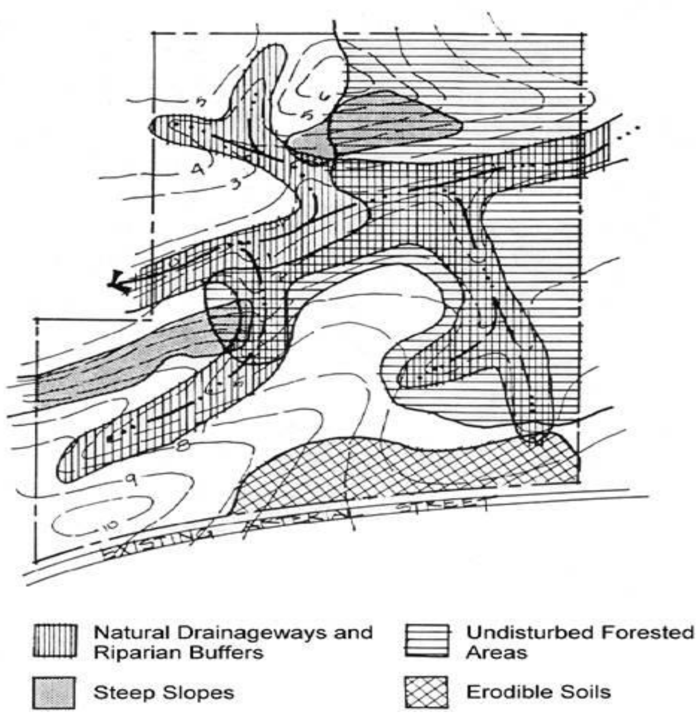


Figure 1.4.2-1 Example of Natural Feature Delineation

(Source: MPCA, 1989)

Preserve Undisturbed Natural Areas

Description: Important natural features and areas such as undisturbed forested and vegetated areas, natural drainageways, stream corridors, wetlands and other important site features should be delineated and placed into conservation areas.

KEY BENEFITS	USING THIS PRACTICE
• Conserving undisturbed natural areas helps to preserve a portion of the site's natural predevelopment hydrology. • Can be used as nonstructural stormwater filtering and infiltration zones. • Helps to preserve the site's natural character and aesthetic features. • May increase the value of the developed property. • A stormwater site design credit can be taken if allowed by Columbia County (see subsection 1.4.4).	☑ Delineate natural areas before performing site layout and design. ☑ Ensure that conservation areas and native vegetation are protected in an undisturbed state throughout construction and occupancy.

Discussion

Preserving natural conservation areas such as undisturbed forested and vegetated areas, natural drainageways, stream corridors and wetlands on a development site helps to preserve the original hydrology of the site and aids in reducing the generation of stormwater runoff and pollutants. Undisturbed vegetated areas also promote soil stabilization and provide for filtering, infiltration and evapotranspiration of runoff.

Natural conservation areas are typically identified through a site analysis using maps and aerial/satellite photography, or by conducting a site visit. These areas should be delineated before any site design, clearing or construction begins. When done before the concept plan phase, the planned conservation areas can be used to guide the layout of the site. Figure 1.4.2-2 shows a site map with undisturbed natural areas delineated.

Conservation areas should be incorporated into site plans and clearly marked on all construction and grading plans to ensure that equipment is kept out of these areas and that native vegetation is kept in an undisturbed state. The boundaries of each conservation area should be mapped by carefully determining the limit which should not be crossed by construction activity.

Once established, natural conservation areas must be protected during construction and managed after occupancy by a responsible party able to maintain the areas in a natural state in perpetuity. Typically, conservation areas are protected by legally enforceable deed restrictions, conservation easements, and maintenance agreements.

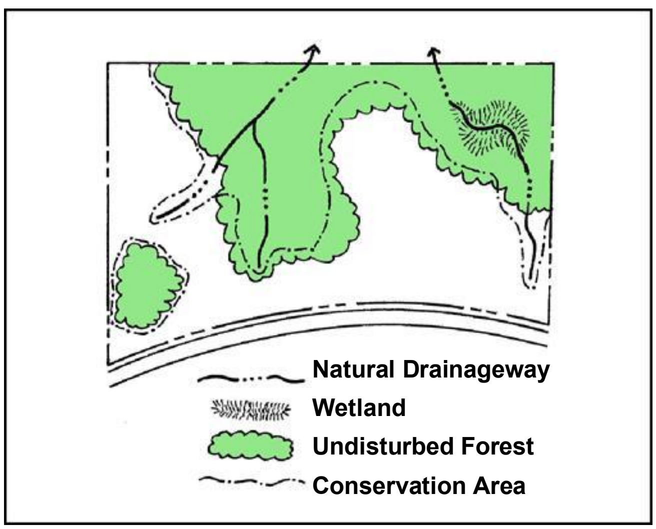


Figure 1.4.2-2 Delineation of Natural Conservation Areas

Preserve Riparian Buffers

Description: Naturally vegetated buffers should be delineated and preserved along perennial streams, rivers, lakes, and wetlands.

KEY BENEFITS	USING THIS PRACTICE
• Riparian buffers can be used as nonstructural stormwater filtering and infiltration zones. • Keeps structures out of the floodplain and provides a right-of-way for large flood events. • Helps to preserve riparian ecosystems and habitats. • A stormwater site design credit can be taken (see subsection 1.4.4). Credit means cost savings by reducing the size of Structural Stormwater Control and Conveyance Facilities	☑ Delineate and preserve naturally vegetated riparian buffers. ☑ Ensure that buffers and native vegetation are protected throughout construction and occupancy.

Discussion

A riparian buffer is a special type of natural conservation area along a stream, wetland or shoreline where development is restricted or prohibited. The primary function of buffers is to protect and physically separate a stream, lake or wetland from future disturbance or encroachment. If properly designed, a buffer can provide stormwater management functions, can act as a right-of-way during floods, and can sustain the integrity of stream ecosystems and habitats. An example of a riparian stream buffer is shown in Figure 1.4.2-3.

Forested riparian buffers should be maintained and reforestation should be encouraged where no wooded buffer exists. Proper restoration should include all layers of the forest plant community, including understory, shrubs and groundcover, not just trees. A riparian buffer can be of fixed or variable width, but should be continuous and not interrupted by impervious areas that would allow stormwater to concentrate and flow into the stream without first flowing through the buffer.

Figure 1.4.2-3 Riparian Stream Buffer

Ideally, riparian buffers should be sized to include the 100-year floodplain as well as steep banks and freshwater wetlands. The buffer depth needed to perform properly will depend on the size of the stream and the surrounding conditions, but a minimum 25-foot undisturbed vegetative buffer is needed for even the smallest perennial streams and a 50-foot or larger undisturbed buffer is ideal. Even with a 25-foot undisturbed buffer, additional zones can be added to extend the total buffer to at least 75 feet from the edge of the stream. The three distinct zones within the 75-foot depth are shown in Figure 1.4.2-4. The function, vegetative target and allowable uses vary by zone as described in Table 1.4.2-1.

These recommendations are minimum standards to apply to most streams. Some streams and watershed may require additional measures to achieve protection.

The streamside or inner zone should consist of a minimum of 25 feet of undisturbed mature forest. In addition to runoff protection, this zone provides bank stabilization as well as shading and protection for the stream. This zone should also include wetlands and any critical habitats, and its width should be adjusted accordingly. The middle zone provides a transition between upland development and the inner zone and should consist of managed woodland that allows for infiltration and filtration of runoff. An outer zone allows more clearing and acts as a further setback for impervious surfaces. It also functions to prevent encroachment and filter runoff. It is here that flow into the buffer should be transformed from concentrated flow into sheet flow to maximize ground contact with the runoff.

Development within the riparian buffer should be limited only to those structures and facilities that are absolutely necessary. Such limited development should be specifically identified in any codes or ordinances enabling the buffers. When construction activities do occur within the riparian corridor, specific mitigation measures should be required, such as deeper buffers or riparian buffer improvements.

Generally, the riparian buffer should remain in its natural state. However, some maintenance is periodically necessary, such as planting to minimize concentrated flow, the removal of exotic plant species when these species are detrimental to the vegetated buffer and the removal of diseased or damaged trees.

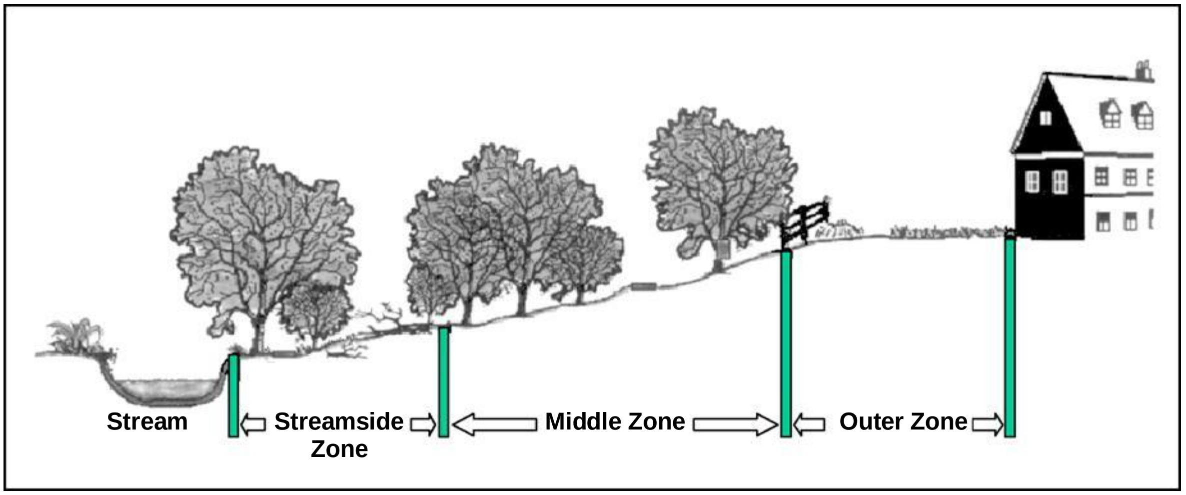


Figure 1.4.2-4 Three-Zone Stream Buffer System

Table 1.4.2-1 Riparian Buffer Management Zones

	Streamside Zone	**Middle Zone**	**Outer Zone**
Width	Minimum 25 feet plus wetlands and critical habitat	Variable depending on stream order, slope, and 100-year floodplain (min. 25 ft)	25-foot minimum setback from structures
Vegetative Target	Undisturbed mature forest. Reforest if necessary.	Managed forest, some clearing allowed.	Forest encouraged, but usually turf grass.
Allowable Uses	**Very Restricted** e.g., flood control, utility easements	**Restricted** e.g., some recreational uses, some stormwater controls, bike paths	**Unrestricted** e.g., residential uses including lawn, garden, most stormwater controls

Better Site Design Practice #3:

Avoid Floodplains

Description: Floodplain areas should be avoided for homes and other structures to minimize risk to human life and property damage, and to allow the natural stream corridor to accommodate flood flows.

KEY BENEFITS	USING THIS PRACTICE
• Preserving floodplains provides a natural right-of-way and temporary storage for large flood events • Keeps people and structures out of harm's way • Helps to preserve riparian ecosystems and habitats • Can be combined with riparian buffer protection to create linear greenways	☑ Obtain maps of the 100-year floodplain from the Columbia County ☑ Ensure that all development activities do not encroach on the designated floodplain areas

Discussion

Floodplains are the low-lying flat lands that border streams and rivers. When a stream reaches its capacity and overflows its channel after storm events, the floodplain provides for storage and conveyance of these excess flows. In their natural state they reduce flood velocities and peak flow rates by the passage of flows through dense vegetation. Floodplains also play an important role in reducing sedimentation and filtering runoff, and provide habitat for both aquatic and terrestrial life. Development in floodplain areas can reduce the ability of the floodplain to convey stormwater, potentially causing safety problems or significant damage to the site in question, as well as to both upstream and downstream properties. Most communities regulate the use of floodplain areas to minimize the risk to human life as well as to avoid flood damage to structures and property.

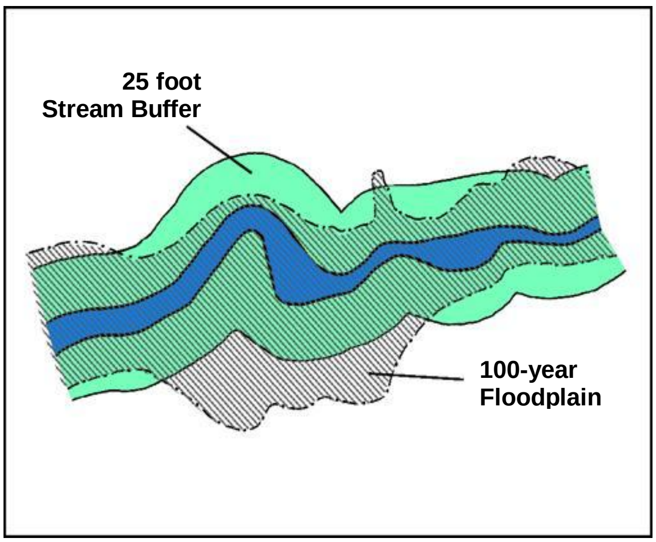


Figure 1.4.2-5 Floodplain Boundaries in Relation to a Riparian Buffer

As such, floodplain areas should be avoided on a development site. Ideally, the entire 100-year full-build-out floodplain should be avoided for clearing or building activities, and should be preserved in a natural undisturbed state where possible. Floodplain protection is complementary to riparian buffer preservation. Both of these better site design practices preserve stream corridors in a natural state and allow for the protection of vegetation and habitat. Depending on the site topography, 100-year floodplain boundaries may lie inside or outside of a preserved riparian buffer corridor, as shown in Figure 1.4.2-5.

Maps of the 100-year floodplain can typically be obtained through the Columbia County. Developers and builders should also ensure that their site design comply will any other relevant local floodplain and FEMA requirements.

Avoid Steep Slopes

Description: Steep slopes should be avoided due to the potential for soil erosion and increased sediment loading. Excessive grading and flattening of hills and ridges should be minimized.

KEY BENEFITS	USING THIS PRACTICE
• Preserving steep slopes helps to prevent soil erosion and degradation of stormwater runoff • Steep slopes can be kept in an undisturbed natural condition to help stabilize hillsides and soils • Building on flatter areas will reduce the need for cut-and-fill and grading	☑ Obtain maps of the 100-year floodplain from the Columbia County ☑ Ensure that all development activities do not encroach on the designated floodplain areas

Discussion

Developing on steep slope areas has the potential to cause excessive soil erosion and stormwater runoff during and after construction. Past studies by the SCS (now NRCS) and others have shown that soil erosion is significantly increased on slopes of 15% or greater. In addition, the nature of steep slopes means that greater areas of soil and land area are disturbed to locate facilities on them compared to flatter slopes as demonstrated in Figure 1.4.2-6.

Therefore, development on slopes with a grade of 15% or greater should be avoided if possible to limit soil loss, erosion, excessive stormwater runoff, and the degradation of surface water. Excessive grading should be avoided on all slopes, as should the flattening of hills and ridges. Steep slopes should be kept in an undisturbed natural condition to help stabilize hillsides and soils.

On slopes greater than 25%, no development, regrading, or stripping of vegetation should be considered unless the disturbance is for roadway crossings or utility construction and it can be demonstrated that the roadway or utility improvements are absolutely necessary in the sloped area.

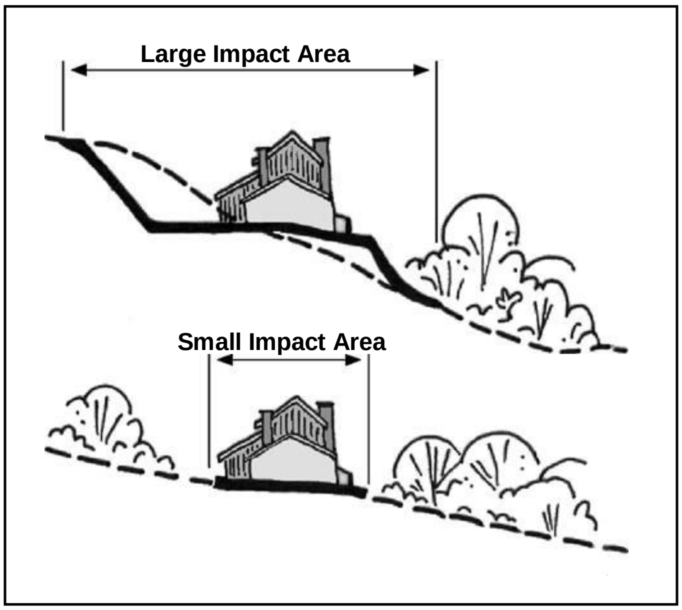


Figure 1.4.2-6 Flattening Steep Slopes for Building Sites Uses More Land Area than Building on Flatter Slopes

(Source: MPCA, 1989)

Minimize Siting on Porous or Erodible Soils

Description: Porous soils such as sand and gravels provide an opportunity for ground water recharge of stormwater runoff and should be preserved as a potential stormwater management option. Unstable or easily erodible soils should be avoided due to their greater erosion potential.

KEY BENEFITS	USING THIS PRACTICE
• Areas with highly permeable soils can be used as nonstructural stormwater infiltration zones. A stormwater site design credit can be taken if allowed by Columbia County (see subsection 1.4.4). • Avoiding high erodible or unstable soils can prevent erosion and sedimentation problems and water quality degradation.	☑ Use soil surveys to determine site soil types. ☑ Leave areas of porous or highly erodible soils as undisturbed conservation areas.

Discussion

Infiltration of stormwater into the soil reduces both the volume and peak discharge of runoff from a given rainfall event, and also provides for water quality treatment and groundwater recharge. Soils with maximum permeabilities (hydrologic soil group A and B soils such as sands and sandy loams) allow for the most infiltration of runoff into the subsoil. Thus, areas of a site with these soils should be conserved as much as possible and these areas should ideally be incorporated into undisturbed natural or open space areas. Conversely, buildings and other impervious surfaces should be located on those portions of the site with the *least* permeable soils.

Similarly, areas on a site with highly erodible or unstable soils should be avoided for land disturbing activities and buildings to prevent erosion and sedimentation problems as well as potential future structural problems. These areas should be left in an undisturbed and vegetated condition.

Soils on a development site should be mapped in order to preserve areas with porous soils, and to identify those areas with unstable or erodible soils as shown in Figure 1.4.2-7. Soil surveys can provide a considerable amount of information relating to all relevant aspects of soils. Appendix B of this Manual provides permeability, shrink-swell potential and hydrologic soils group information for all Georgia soil series. General soil types should be delineated on concept site plans to guide site layout and the placement of buildings and impervious surfaces.

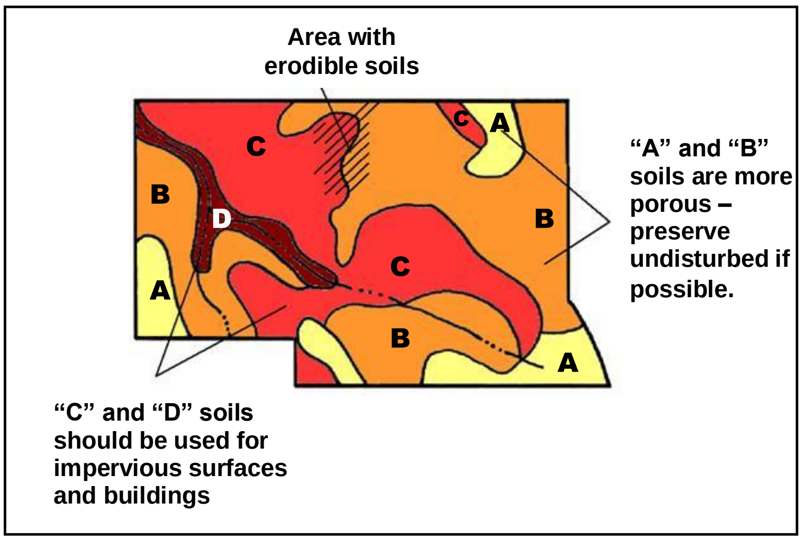


Figure 1.4.2-7 Soil Mapping Information Can Be Used to Guide Development

1.4.2.2 Lower Impact Site Design Techniques

After a site analysis has been performed and conservation areas have been delineated, there are numerous opportunities in the site design and layout phase to reduce both water quantity and quality impacts of stormwater runoff. These primarily deal with the location and configuration of impervious surfaces or structures on the site and include the following practices and techniques covered over the next several pages:

- Fit the Design to the Terrain
- Locate Development in Less Sensitive Areas
- Reduce Limits of Clearing and Grading
- Utilize Open Space Development
- Consider Creative Development Design

The goal of lower impact site design techniques is to lay out the elements of the development project in such a way that the site design (i.e. placement of buildings, parking, streets and driveways, lawns, undisturbed vegetation, buffers, etc.) is optimized for effective stormwater management. That is, the site design takes advantage of the site's natural features, including those placed in conservation areas, as well as any site constraints and opportunities (topography, soils, natural vegetation, floodplains, shallow bedrock, high water table, etc.) to prevent both on-site and downstream stormwater impacts.

Figure 1.4.2-8 shows a development that has utilized several lower impact site design techniques in its overall layout and design.

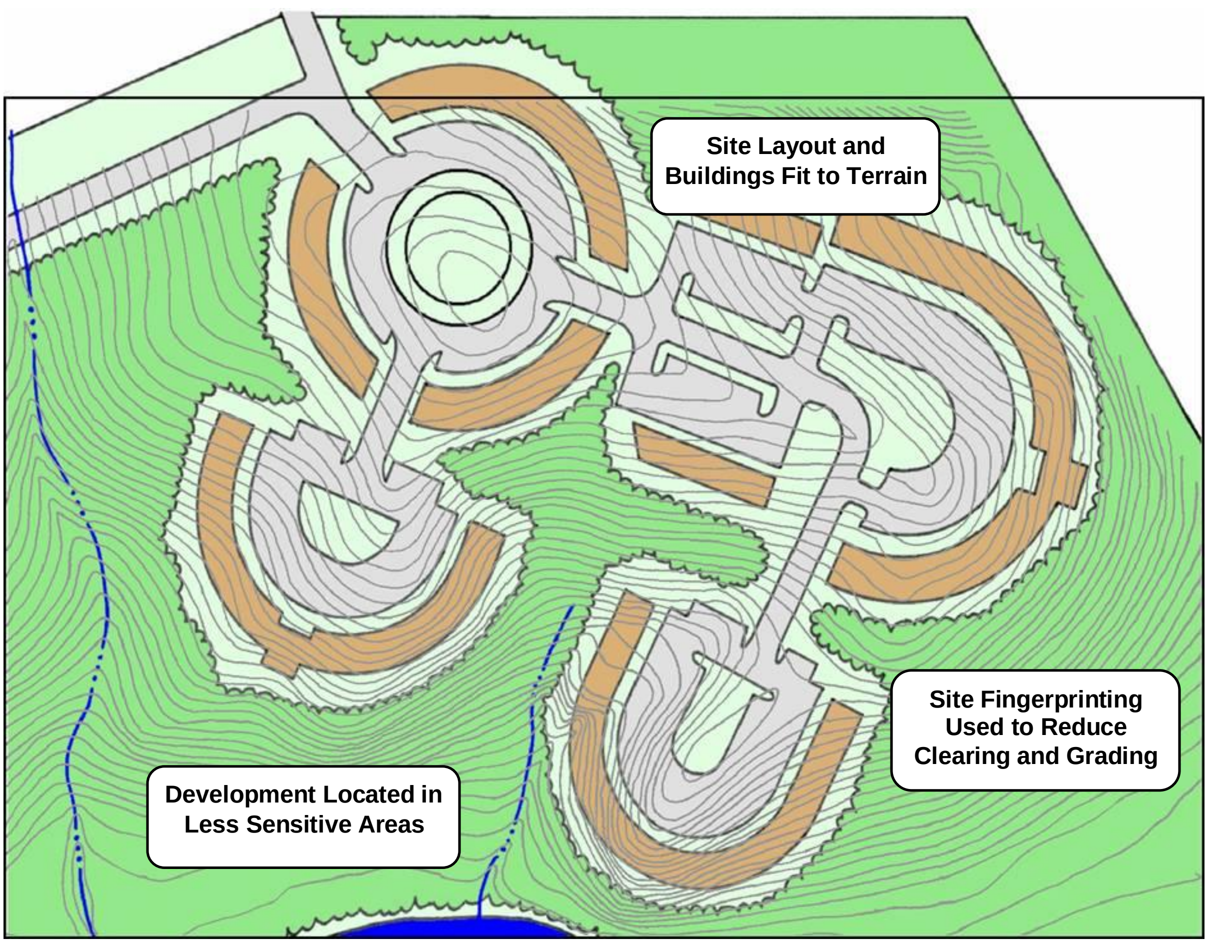


Figure 1.4.2-8 Development Design Utilitizing Several Lower Impact Site Design Techniques

Fit Design to the Terrain

Description: The layout of roadways and buildings on a site should generally conform to the landforms on a site. Natural drainageways and stream buffer areas should be preserved by designing road layouts around them. Buildings should be sited to utilize the natural grading and drainage system and avoid the unnecessary disturbance of vegetation and soils.

KEY BENEFITS	USING THIS PRACTICE
• Helps to preserve the natural hydrology and drainageways of a site. • Reduces the need for grading and land disturbance. • Provides a framework for site design and layout.	☑ Develop roadway patterns to fit the site terrain. Locate buildings and impervious surfaces away from steep slopes, drainageways and floodplains.

Discussion

All site layouts should be designed to conform with or "fit" the natural landforms and topography of a site. This helps to preserve the natural hydrology and drainageways on the site, as well as reduces the need for grading and disturbance of vegetation and soils. Figure 1.4.2-9 illustrates the placement of roads and homes in a residential development.

Roadway patterns on a site should be chosen to provide access schemes which match the terrain. In rolling or hilly terrain, streets should be designed to follow natural contours to reduce clearing and grading. Street hierarchies with local streets branching from collectors in short loops and cul-de-sacs along ridgelines help to prevent the crossing of streams and drainageways as shown in Figure 1.4.2-10. In flatter areas, a traditional grid pattern of streets or "fluid" grids which bend and may be interrupted by natural drainageways may be more appropriate (see Figure 1.4.2-11). In either case, buildings and impervious surfaces should be kept off of steep slopes, away from natural drainageways, and out of floodplains and other lower lying areas. In addition, the major axis of buildings should be oriented parallel to existing contours.

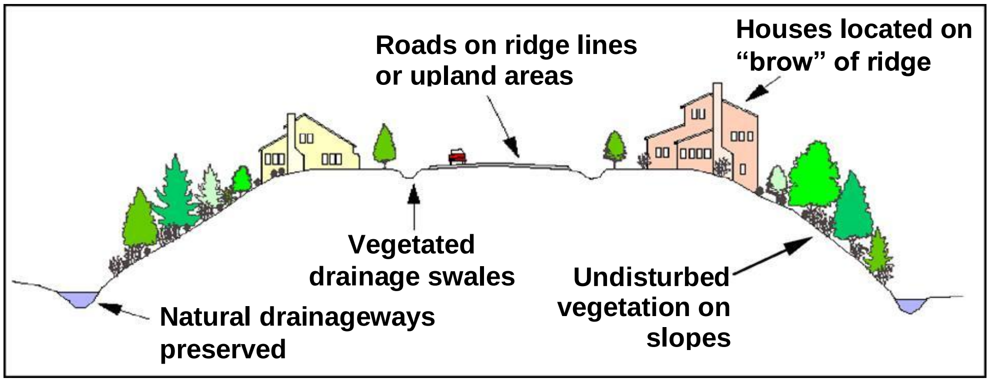


Figure 1.4.2-9 Preserving the Natural Topography of the Site

(Adapted from Sykes, 1989)

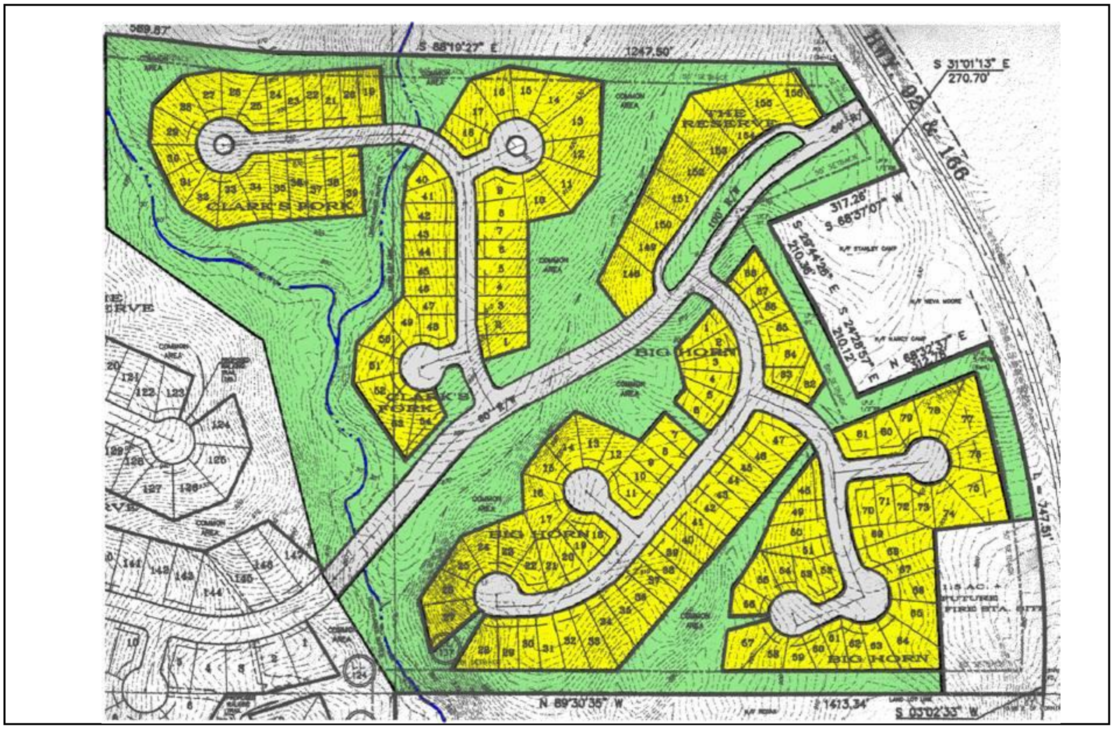


Figure 1.4.2-10 Subdivision Design for Hilly or Steep Terrain Utilizes Branching Streets from Collectors that Preserves Natural Drainageways and Stream Corridors

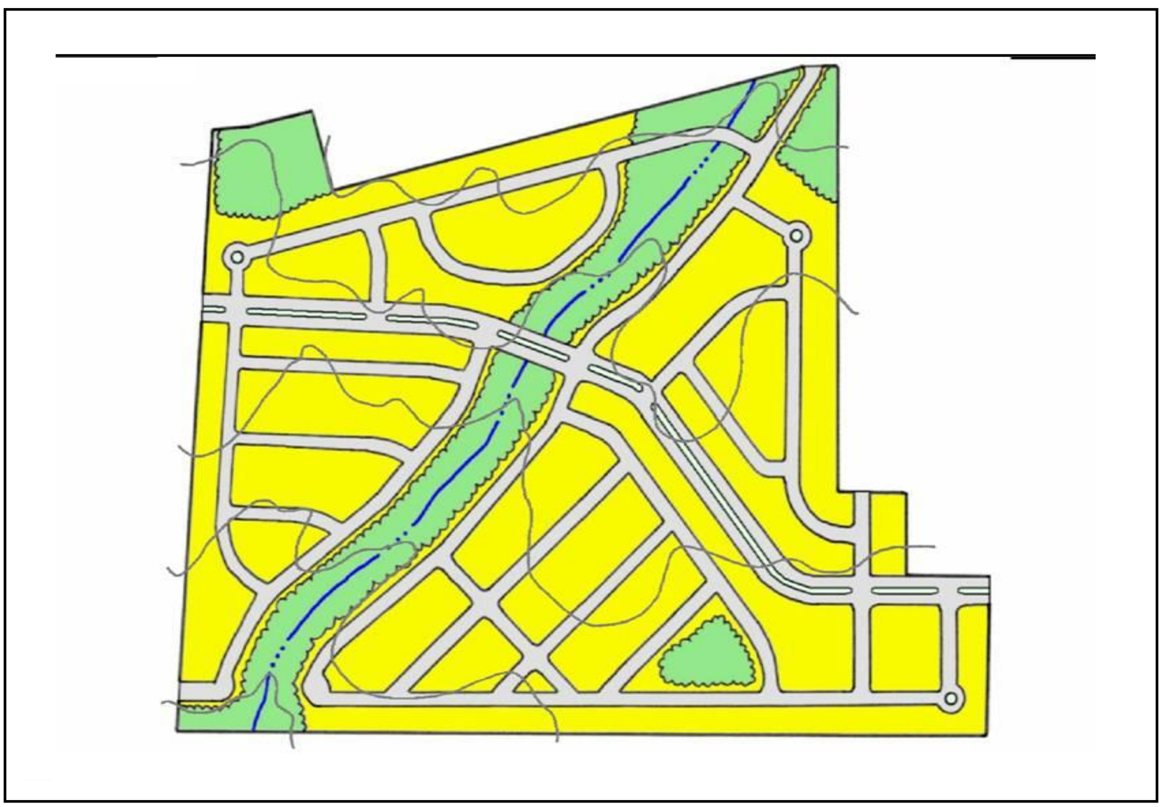


Figure 1.4.2-11 A Subdivision Design for Flat Terrain Uses a Fluid Gri that is interrupted by the Stream Corridor

Better Site Design Practice #7:

Locate Development in Less Sensitive Areas

Description: To minimize the hydrologic impacts on the existing site land cover, the area of development should be located in areas of the site that are less sensitive to disturbance or have a lower value in terms of hydrologic function.

KEY BENEFITS	USING THIS PRACTICE
• Helps to preserve the natural hydrology and drainageways of a site. • Makes most efficient use of natural site features for preventing and mitigating stormwater impacts. • Provides a framework for site design and layout.	☑ Lay out the site design to minimize the hydrologic impact of structures and impervious surfaces.

Discussion

In much the same way that a development should be designed to conform to terrain of the site, a site layout should also be designed so that the areas of development are placed in the locations of the site that minimize the hydrologic impact of the project. This is accomplished by steering development to areas of the site that are less sensitive to land disturbance or have a lower value in terms of hydrologic function using the following methods:

- Locate buildings and impervious surfaces away from stream corridors, wetlands and natural drainageways. Use buffers to preserve and protect riparian areas and corridors.
- Areas of the site with porous soils should left in an undisturbed condition and/or used as stormwater runoff infiltration zones. Buildings and impervious surfaces should be located in areas with less permeable soils.
- Avoid land disturbing activities or construction on areas with steep slopes or unstable soils.
- Minimize the clearing of areas with dense tree canopy or thick vegetation, and ideally preserve them as natural conservation areas
- Ensure that natural drainageways and flow paths are preserved, where possible. Avoid the filling or grading of natural depressions and ponding areas.

Figure 1.4.2-12 shows a development site where the natural features have been mapped in order to delineate the hydrologically sensitive areas. Through careful site planning, sensitive areas can be set aside as natural open space areas (see Better Site Design Practice #9). In many cases, such areas can be used as buffer spaces between land uses on the site or between adjacent sites.

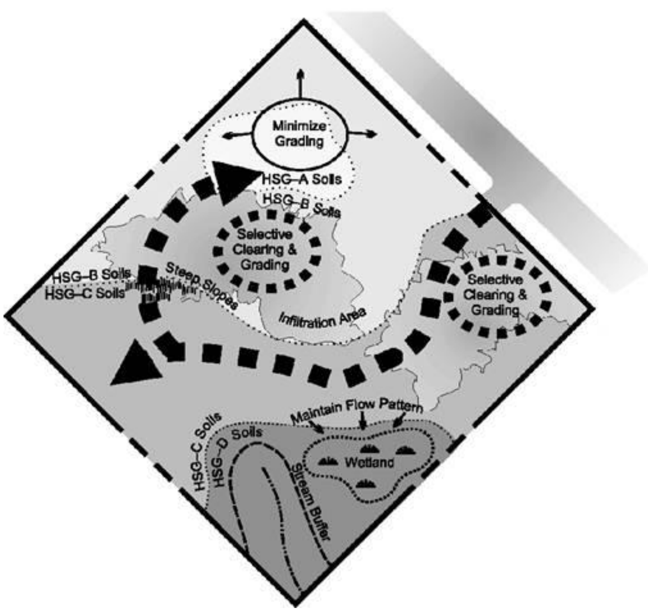


Figure 1.4.2-12 Guiding Development to Less Sensitive Areas of a Site

(Source: Prince George's County, MD, 1999)

Reduce Limits of Clearing and Grading

Description: Clearing and grading of the site should be limited to the minimum amount needed for the development and road access. Site footprinting should be used to disturb the smallest possible land area on a site.

KEY BENEFITS	USING THIS PRACTICE
• Preserves more undisturbed natural areas on a development site. • Techniques can be used to help protect natural conservation areas and other site features.	☑ Establish limits of disturbance for all development activities. ☑ Use site footprinting to minimize clearing and land disturbance.

Discussion

Minimal disturbance methods should be used to limit the amount of clearing and grading that takes place on a development site, preserving more of the undisturbed vegetation and natural hydrology of a site. These methods include:

- Establishing a limit of disturbance (LOD) based on maximum disturbance zone radii/lengths. These maximum distances should reflect reasonable construction techniques and equipment needs together with the physical situation of the development site such as slopes or soils. LOD distances may vary by type of development, size of lot or site, and by the specific development feature involved.
- Using site "footprinting" which maps all of the limits of disturbance to identify the smallest possible land area on a site which requires clearing or land disturbance. Examples of site footprinting is illustrated in Figures 1.4.2-13 and 1.4.2-14.
- Fitting the site design to the terrain.
- Using special procedures and equipment which reduce land disturbance.

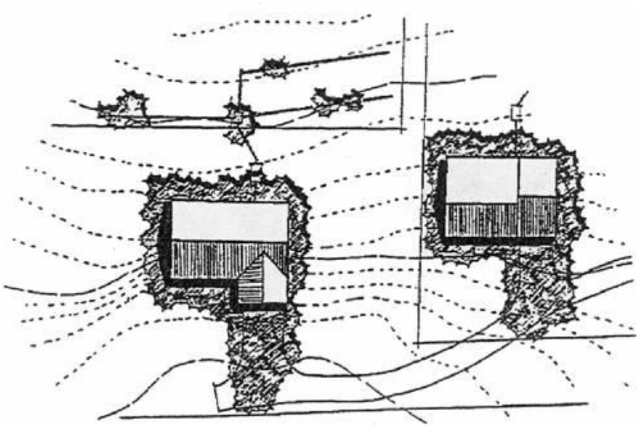


Figure 1.4.2-13 Establishing Limits of Clearing (Source: DDNREC, 1997)

Figure 1.4.2-14 Example of Site Footprinting

Better Site Design Practice #9:

Utilize Open Space Development

Description: Open space site designs incorporate smaller lot sizes to reduce overall impervious cover while providing more undisturbed open space and protection of water resources.

KEY BENEFITS	USING THIS PRACTICE
• Preserves conservation areas on a development site. • Can be used to preserve natural hydrology and drainageways. • Can be used to help protect natural conservation areas and other site features. • Reduces the need for grading and land disturbance. • Reduces infrastructure needs and overall development costs.	☑ Use a site design which concentrates development and preserves open space and natural areas of the site.

Discussion

Open space development, also known as *conservation development* or *clustering*, is a better site design technique that concentrates structures and impervious surfaces in a compact area in one portion of the development site in exchange for providing open space and natural areas elsewhere on the site. Typically smaller lots and/or nontraditional lot designs are used to cluster development and create more conservation areas on the site.

Open space developments have many benefits compared with conventional commercial developments or residential subdivisions: they can reduce impervious cover, stormwater pollution, construction costs, and the need for grading and landscaping, while providing for the conservation of natural areas. Figures 1.4.2-15 and 1.4.2-16 show examples of open space developments.

Along with reduced imperviousness, open space designs provide a host of other environmental benefits lacking in most conventional designs. These developments reduce potential pressure to encroach on conservation and buffer areas because enough open space is usually reserved to accommodate these protection areas. As less land is cleared during the construction process, alteration of the natural hydrology and the potential for soil erosion are also greatly diminished. Perhaps most importantly, open space design reserves 25 to 50 percent of the development site in conservation areas that would not otherwise be protected.

Open space developments can also be significantly less expensive to build than conventional projects. Most of the cost savings are due to reduced infrastructure cost for roads and stormwater management controls and conveyances. While open space developments are frequently less expensive to build, developers find that these properties often command higher prices than those in more conventional developments. Several studies estimate that residential properties in open space developments garner premiums that are higher than conventional subdivisions and moreover, sell or lease at an increased rate.

Once established, common open space and natural conservation areas must be managed by a responsible party able to maintain the areas in a natural state in perpetuity. Typically, the conservation areas are protected by legally enforceable deed restrictions, conservation easements, and maintenance agreements.

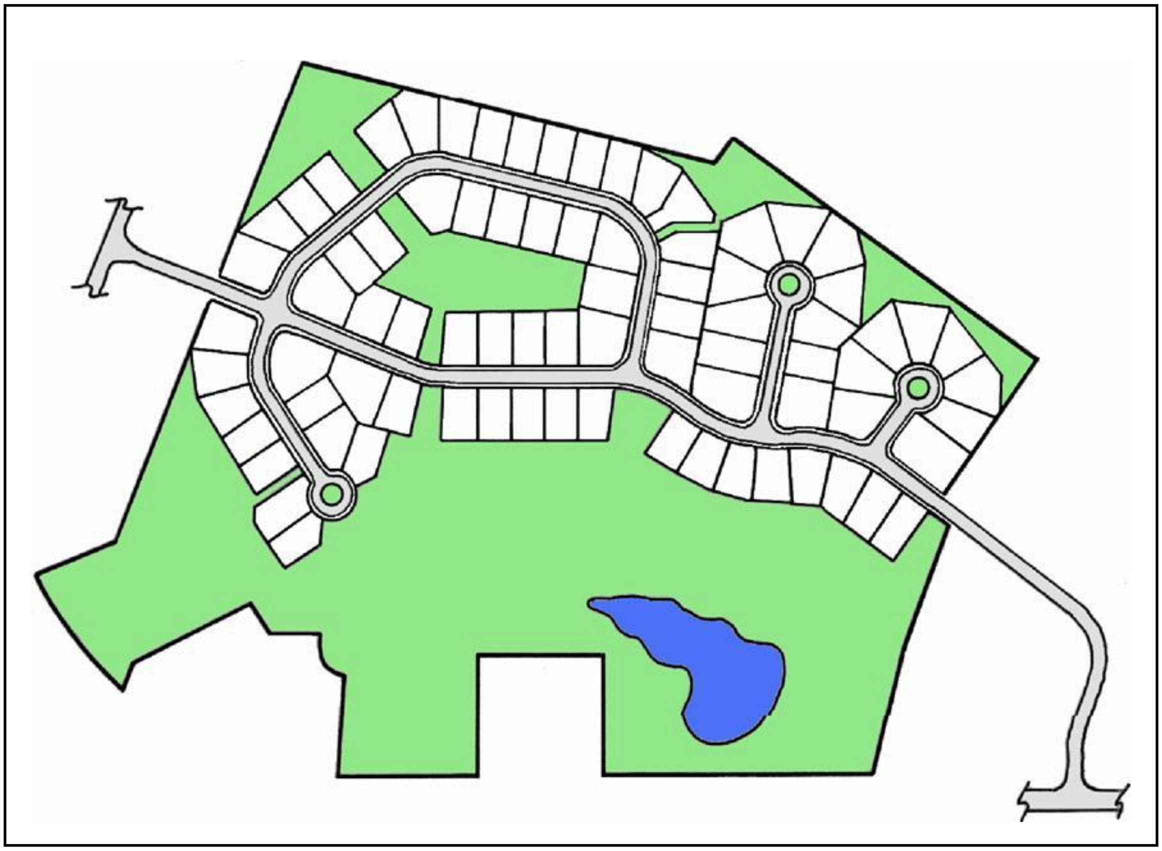


Figure 1.4.2-15 Open Space Subdivision Site Design Example

Figure 1.4.2-16 Aerial View of an Open Space Subdivision

Better Site Design Practice #10:

Consider Creative Development Design

Description: Planned Unit Developments (PUDs) allow a developer or site designer the flexibility to design a residential, commercial, industrial or mixed-use development in a fashion that promotes effective stormwater management and the protection of environmentally sensitive areas.

KEY BENEFITS	USING THIS PRACTICE
• Allows flexibility to developers to implement creative site designs which include stormwater better site design practices. • May be useful for implementing an open space development.	☑ Check with your Columbia County to determine if the community supports PUDs. ☑ Determine the type and nature of deviations allowed and other criteria for receiving PUD approval.

Discussion

A Planned Unit Development (PUD) is a type of planning approval available in some communities which provides greater design flexibility by allowing deviations from the typical development standards required by the Columbia County zoning code with additional variances or zoning hearings. The intent is to encourage better designed projects through the relaxation of some development requirements, in exchange for providing greater benefits to the community. PUDs can be used to implement many of the other stormwater better site design practices covered in this Manual and to create site designs that maximize natural nonstructural approaches to stormwater management.

Examples of the types of zoning deviations which are often allowed through a PUD process include:

- Allowing uses not listed as permitted, conditional or accessory by the zoning district in which the property is located
- Modifying lot size and width requirements
- Reducing building setbacks and frontages from property lines
- Altering parking requirements
- Increasing building height limits

Many of these changes are useful in reducing the amount of impervious cover on a development site (see Better Site Design Practices #11 through #16).

1.4.2.3 Reduction of Impervious Cover

The level of impervious cover, i.e. rooftops, parking lots, roadways, sidewalks and other surfaces that do not allow rainfall to infiltrate into the soil, is an essential factor to consider in better site design for stormwater management. Increased impervious cover means increased stormwater generation and increased pollutant loadings.

Thus by reducing the area of total impervious surface on a site, a site designer can directly reduce the volume of stormwater runoff and associated pollutants that are generated. It can also reduce the size and cost of necessary infrastructure for stormwater drainage, conveyance, and control and treatment. Some of the ways that impervious cover can be reduced in a development include:

- Reduce Roadway Lengths
- Reduce Building Footprints
- Reduce the Parking Footprint
- Reduce Setbacks and Frontages
- Use Fewer or Alternative Cul-de-Sacs
- Create Parking Lot Stormwater Islands

Figure 1.4.2-17 shows an example of a residential subdivision that employed several of these principles to reduce the overall imperviousness of the development. The next several pages cover these methods in more detail.

Figure 1.4.2-17 Example of Reducing Impervious Cover (clockwise from upper left): (a) Cul-de-Sac with Landscaped Island; (b) Narrower Residential Street; (c) Landscape Median in Roadway; and (d) "Green" Parking Lot with Landscaped Islands

Reduce Building Footprints

Description: The impervious footprint of commercial buildings and residences can be reduced by using alternate or taller buildings while maintaining the same floor to area ratio.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated.	☑ Use alternate or taller building designs to reduce the impervious footprint of buildings.

Discussion

In order to reduce the imperviousness associated with the footprint and rooftops of buildings and other structures, alternative and/or vertical (taller) building designs should be considered. Consolidate functions and buildings, as required, or segment facilities to reduce the footprint of individual structures. Figure 1.4.2-19 shows the reduction in impervious footprint by using a taller building design.

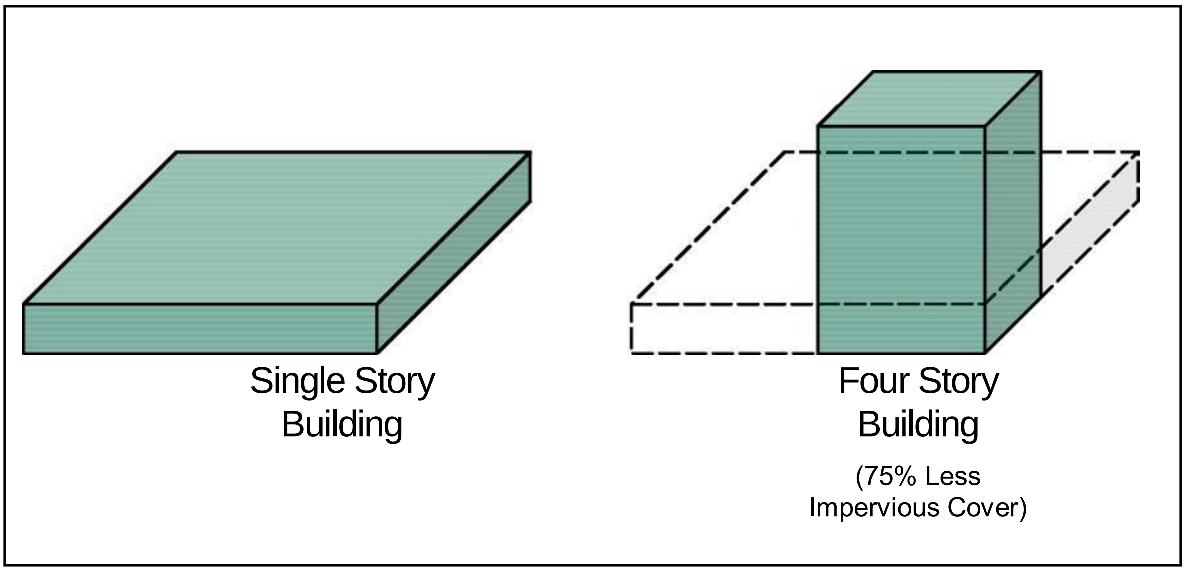


Figure 1.4.2-18 Building Up Rather Than Out Can Reduce the Amount of Impervious Cover

Better Site Design Practice #12:

Reduce the Parking Footprint

Description: Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, parking decks, and using porous paver surfaces or porous concrete in overflow parking areas where feasible and possible.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated.	☑ Reduce the number of parking spaces. ☑ Minimize stall dimensions. ☑ Consider parking structures and shared parking ☑ Use alternative porous surface for overflow areas.

Discussion

Setting maximums for parking spaces, minimizing stall dimensions, using structured parking, encouraging shared parking and using alternative porous surfaces can all reduce the overall parking footprint and site imperviousness.

Many parking lot designs result in far more spaces than actually required. This problem is exacerbated by a common practice of setting parking ratios to accommodate the highest hourly parking during the peak season. By determining average parking demand instead, a lower maximum number of parking spaces can be set to accommodate most of the demand. Table 1.4.2-2 provides examples of conventional parking requirements and compares them to average parking demand.

Table 1.4.2-2 Conventional Minimum Parking Ratios (Source: ITE, 1987; Smith, 1984; Wells, 1994)

Land Use	Parking Requirement		Actual Average Parking Demand
	Parking Ratio	Typical Range	
Single family homes	2 spaces per dwelling unit	1.5–2.5	1.11 spaces per dwelling unit
Shopping center	5 spaces per 1000 ft^2 GFA	4.0–6.5	3.97 per 1000 ft^2 GFA
Convenience store	3.3 spaces per 1000 ft^2 GFA	2.0–10.0	--
Industrial	1 space per 1000 ft^2 GFA	0.5–2.0	1.48 per 1000 ft^2 GFA
Medical / dental office	5.7 spaces per 1000 ft^2 GFA	4.5–10.0	4.11 per 1000 ft^2 GFA
GFA = Gross floor area of a building without storage or utility spaces.			

Another technique to reduce the parking footprint is to minimize the dimensions of the parking spaces. This can be accomplished by reducing both the length and width of the parking stall. Parking stall dimensions can be further reduced if compact spaces are provided. While the trend toward larger sport utility vehicles (SUVs) is often cited as a barrier to implementing stall minimization techniques, stall width requirements in most local parking codes are much larger than the widest SUVs.

Structured parking decks are one method to significantly reduce the overall parking footprint by minimizing surface parking. Figure 1.4.2-20 shows a parking deck used for a commercial development.

Figure 1.4.2-19 Structured Parking at an Office Park Development

Shared parking in mixed-use areas and structured parking are techniques that can further reduce the conversion of land to impervious cover. A shared parking arrangement could include usage of the same parking lot by an office space that experiences peak parking demand during the weekday with a church that experiences parking demands during the weekends and evenings.

Utilizing alternative surfaces such as porous pavers or porous concert is an effective way to reduce the amount of runoff generated by parking lots. They can replace conventional asphalt or concrete in both new developments and redevelopment projects. Figure 1.4.2-21 is an example of porous paver used at an overflow lot. Alternative pavers can also capture and treat runoff from other site areas. However, porous pavement surfaces generally require proper installation and more maintenance than conventional asphalt or concrete. For more specific information using these alternative surfaces, see subsection 3.3.5 (Porous Concrete).

Figure 1.4.2-20 Grass Paver Surface Used for Parking

Reduce Setbacks and Frontages

Description: Use smaller front and side setbacks and narrower frontages to reduce total road length and driveway lengths.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated.	☑ Reduce building and home front and side setbacks. ☑ Consider narrower frontages.

Discussion

Building and home setbacks should be shortened to reduce the amount of impervious cover from driveways and entry walks. A setback of 20 feet is more than sufficient to allow a car to park in a driveway without encroaching into the public right of way, and reduces driveway and walk pavement by more than 30% compared with a setback of 30 feet (see Figure 1.4.2-22).

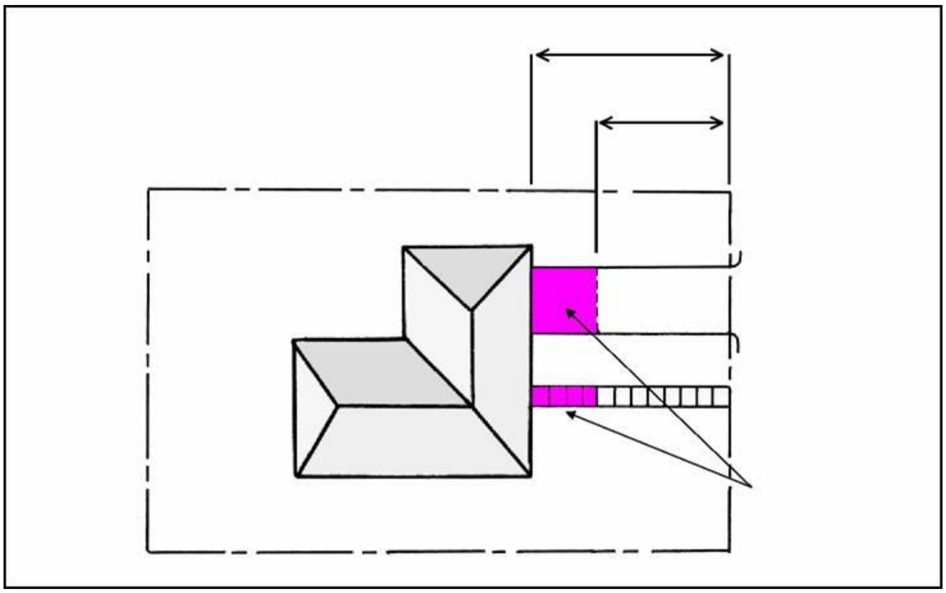


Figure 1.4.2-21 Reduced Impervious Cover by Using Smaller Setbacks

(Adapted from: MPCA, 1989)

Further, reducing side yard setbacks and using narrower frontages can reduce total street length, especially important in cluster and open space designs. Figure 1.4.2-23 shows residential examples of reduced front and side yard setbacks and narrow frontages.

Flexible lot shapes and setback and frontage distances allow site designers to create attractive and unique lots that provide homeowners with enough space while allowing for the preservation of natural areas in a residential subdivision. Figure 1.4.2-24 illustrates various nontraditional lot designs.

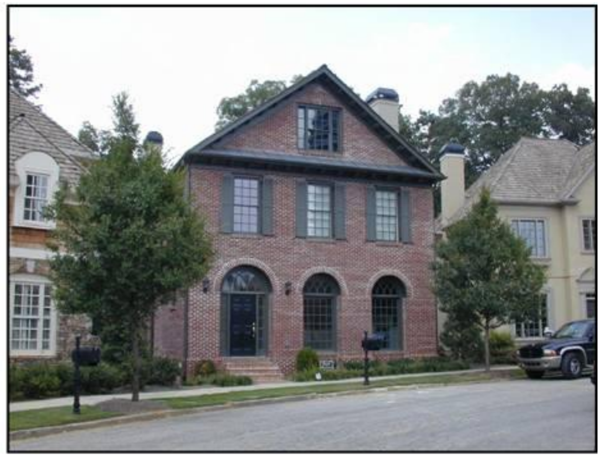
 

Figure 1.4.2-22 Examples of Reduced Frontages and Side Yard Setbacks

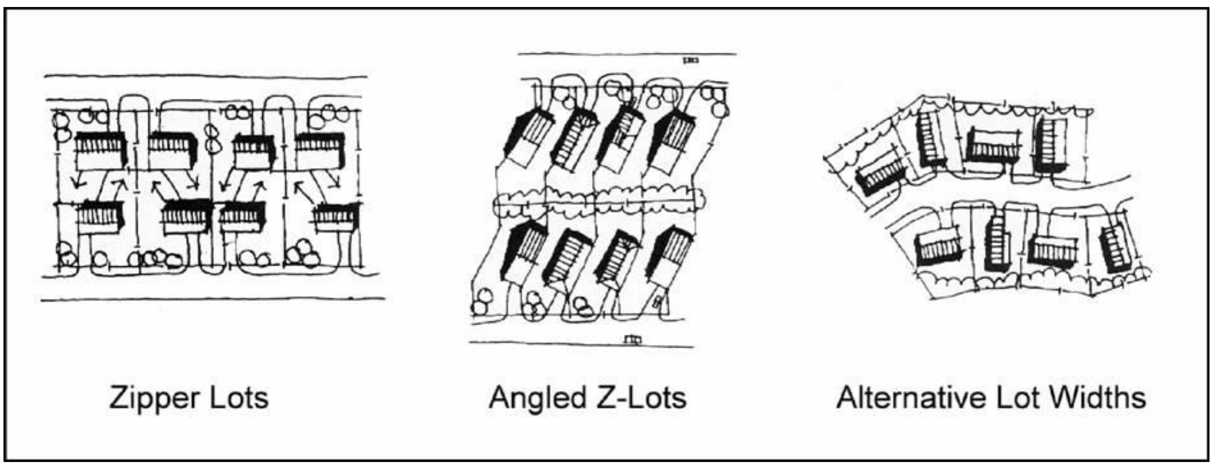


Figure 1.4.2-23 Nontraditional Lot Designs

(Source: ULI, 1992)

Better Site Design Practice #14:

Reduction of Impervious Cover

Use Fewer or Alternative Cul-de-Sacs

Description: Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should also be considered.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated.	☑ Consider alternative cul-de-sac designs.

Discussion

Alternative turnarounds are designs for end-of-street vehicle turnarounds that replace cul-de-sacs and reduce the amount of impervious cover created in developments. Cul-de-sacs are local access streets with a closed circular end that allows for vehicle turnarounds. Many of these cul-de-sacs can have a radius of more than 40 feet. From a stormwater perspective, cul-de-sacs create a huge bulb of impervious cover, increasing the amount of runoff. For this reason, reducing the size of cul-de-sacs through the use of alternative turnarounds or eliminating them altogether can reduce the amount of impervious cover created at a site.

Numerous alternatives create less impervious cover than the traditional 40-foot cul-de-sac. These alternatives include reducing cul-de-sacs to a 30-foot radius and creating hammerheads, loop roads, and pervious islands in the cul-de-sac center (see Figure 1.4.2-25).

Sufficient turnaround area is a significant factor to consider in the design of cul-de-sacs.

In particular, the types of vehicles entering into the cul-de-sac should be considered. Fire trucks, service vehicles and school buses are often cited as needing large turning radii. However, some fire trucks are designed for smaller turning radii. In addition, many newer large service vehicles are designed with a tri-axle (requiring a smaller turning radius) and many school buses usually do not enter individual cul-de-sacs.

Implementing alternative turnarounds will require addressing local regulations and marketing issues. Communities may have specific design criteria for cul-de-sacs and other alternative turnarounds that need to be modified.

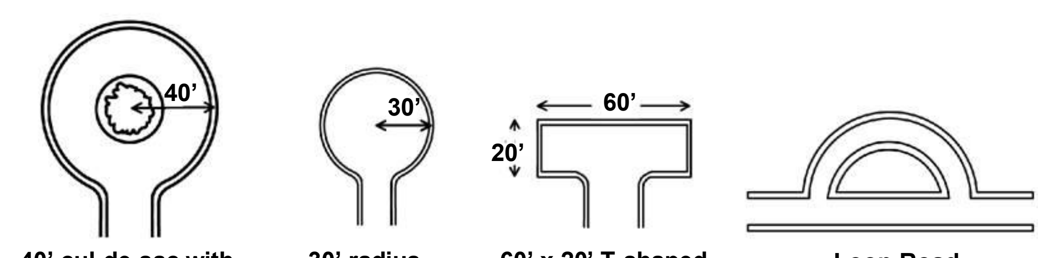


Figure 1.4.2-24 Four Turnaround Options for Residential Streets

(Source: Schueler, 1995)

Better Site Design Practice #15:

Create Parking Lot Stormwater "Islands"

Reduction of Impervious Cover

Description: Provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and / or other practices that can be integrated into required landscaping areas and traffic islands.

KEY BENEFITS	USING THIS PRACTICE
• Reduces the amount of impervious cover and associated runoff and pollutants generated. • Provides an opportunity for the siting of structural control facilities. • Trees in parking lots provide shading for cars and are more visually appealing.	☑ Integrate porous areas such as landscaped islands, swales, filter strips and bioretention areas in a parking lot design.

Discussion

Parking lots should be designed with landscaped stormwater management "islands" which reduce the overall impervious cover of the lot as well as provide for runoff treatment and control in stormwater facilities.

When possible, expanses of parking should be broken up with landscaped islands which include shade trees and shrubs. Fewer large islands will sustain healthy trees better than more numerous very small islands. The most effective solutions in designing for tree roots in parking lots use a long planting strip at least 8 feet wide, constructed with sub-surface drainage and compaction resistant soil.

Structural control facilities such as filter strips, dry swales and bioretention areas can be incorporated into parking lot islands. Stormwater is directed into these landscaped areas and temporarily detained. The runoff then flows through or filters down through the bed of the facility and is infiltrated into the subsurface or collected for discharge into a stream or another stormwater facility. These facilities can be attractively integrated into landscaped areas and can be maintained by commercial landscaping firms. For detailed design specifications of filter strips, enhanced swales and bioretention areas, refer to Chapter 3.

Figure 1.4.2-25 Parking Lot Stormwater "Island"

1.4.2.4 Utilization of Natural Features for Stormwater Management

Traditional stormwater drainage design tends to ignore and replace natural drainage patterns and often results in overly efficient hydraulic conveyance systems. Structural stormwater controls are costly and often can require high levels of maintenance for optimal operation. Through use of natural site features and drainage systems, careful site design can reduce the need and size of structural conveyance systems and controls.

Almost all sites contain natural features which can be used to help manage and mitigate runoff from development. Features on a development site might include natural drainage patterns, depressions, permeable soils, wetlands, floodplains, and undisturbed vegetated areas that can be used to reduce runoff provide infiltration and stormwater filtering of pollutants and sediment, recycle nutrients, and maximize on-site storage of stormwater. Site design should seek to utilize the natural and/or nonstructural drainage system and improve the effectiveness of natural systems rather than to ignore or replace them. These natural systems typically require low or no maintenance and will continue to function many years into the future.

Some of the methods of incorporating natural features into an overall stormwater management site plan include the following practices:

- Use Buffers and Undisturbed Areas
- Use Natural Drainageways Instead of Storm Sewers
- Use Vegetated Swales Instead of Curb and Gutter
- Drain Runoff to Pervious Areas

The following pages cover each practice in more detail.

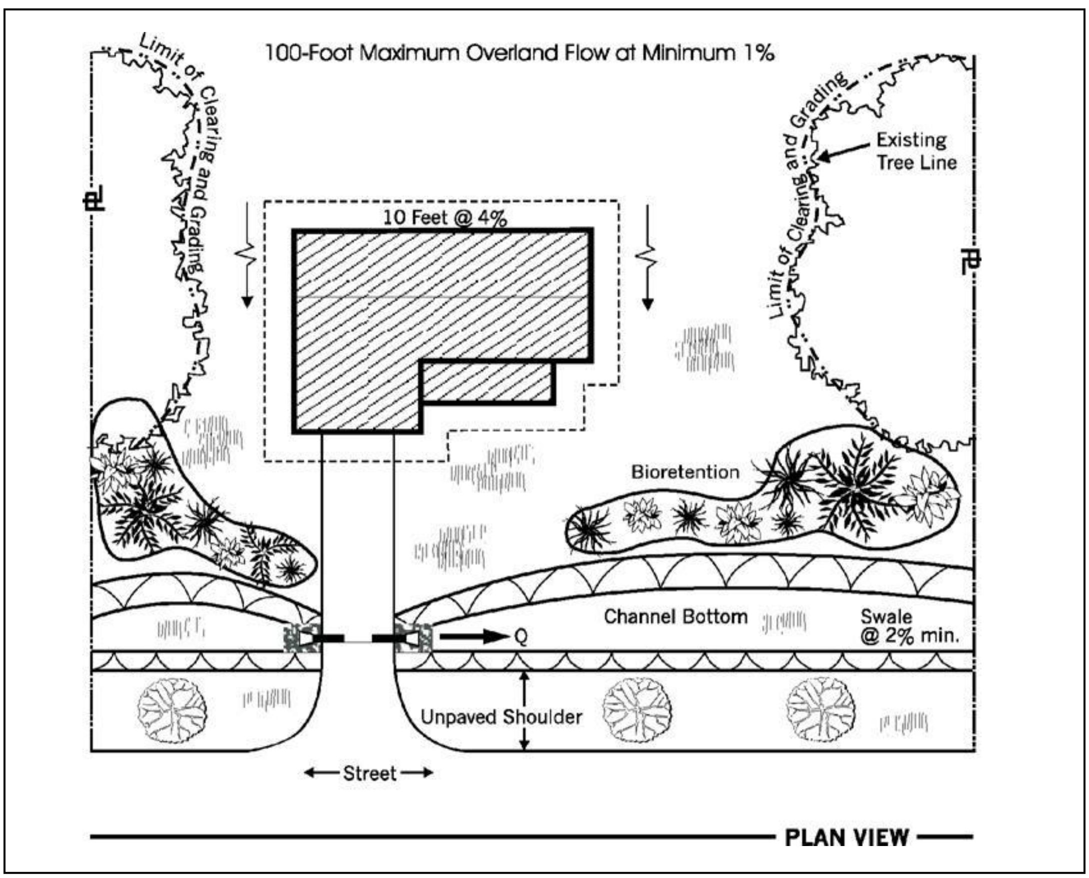


Figure 1.4.2-26 Residential Site Design Using Natural Features for Stormwater Management
(Source: Prince George's County, MD, 1999)

Use Buffers and Undisturbed Areas

Description: Undisturbed natural areas such as forested conservation areas and stream buffers can be used to treat and control stormwater runoff from other areas of the site with proper design.

KEY BENEFITS	USING THIS PRACTICE
• Riparian buffers and undisturbed vegetated areas can be used to filter and infiltrate stormwater runoff. • Natural depressions can provide inexpensive storage and detention of stormwater flows. • A stormwater site design credit can be taken if qualifies (see subsection 1.4.4).	☑ Direct runoff towards buffers and undisturbed areas using a level spreader to ensure sheet flow. ☑ Utilize natural depressions for runoff storage.

Discussion

Runoff can be directed towards riparian buffers and other undisturbed natural areas delineated in the initial stages of site planning to infiltrate runoff, reduce runoff velocity and remove pollutants. Natural depressions can be used to temporarily store (detain) and infiltrate water, particularly in areas with porous (hydrologic soil group A and B) soils.

The objective in utilizing natural areas for stormwater infiltration is to intercept runoff before it has become substantially concentrated and then distribute this flow evenly (as sheet flow) to the buffer or natural area. This can typically be accomplished using a level spreader, as seen in Figure 1.4.2-28. A mechanism for the bypass of higher flow events should be provided to reduce erosion or damage to a buffer or undisturbed natural area.

Carefully constructed berms can be placed around natural depressions and below undisturbed vegetated areas with porous soils to provide for additional runoff storage and/or infiltration of flows.

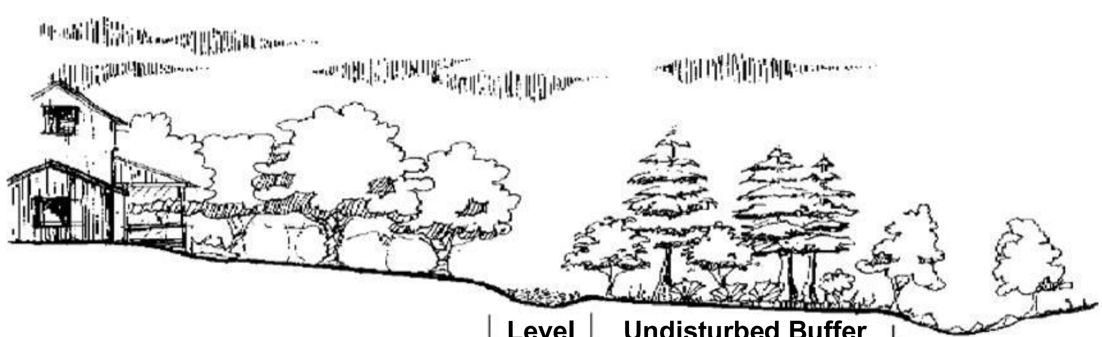


Figure 1.4.2-27 Use of a Level Spreader with a Riparian Buffer
(Adapted from NCDENR, 1998)

Use Natural Drainageways Instead of Storm Sewers

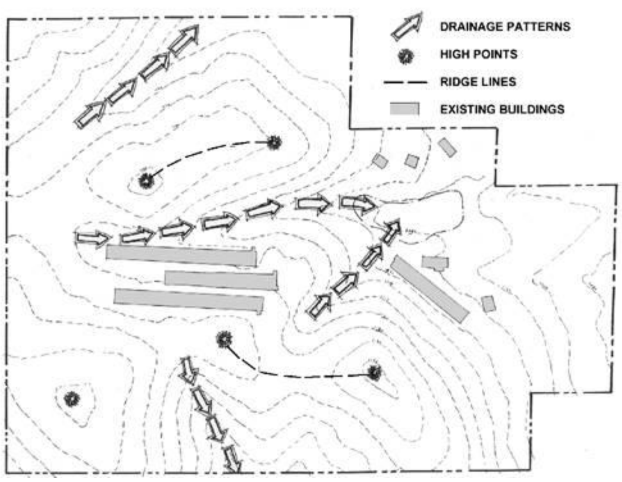
Description: The natural drainage paths of a site can be used instead of constructing underground storm sewers or concrete open channels.

KEY BENEFITS	USING THIS PRACTICE
• Use of natural drainageways reduces the cost of constructing storm sewers or other conveyances, and may reduce the need for land disturbance and grading. • Natural drainage paths are less hydraulically efficient than man-made conveyances, resulting in longer travel times and lower peak discharges. • Can be combined with buffer systems to allow for stormwater filtration and infiltration.	☑ Preserve natural flow paths in the site design. ☑ Direct runoff to natural drainageways, ensuring that peak flows and velocities will not cause channel erosion.

Discussion

Structural drainage systems and storm sewers are designed to be hydraulically efficient in removing stormwater from a site, however, in doing so these systems tend to increase peak runoff discharges, flow velocities and the delivery of pollutants to downstream waters. An alternative is the use of natural drainageways and vegetated swales (where slopes and soils permit) to carry stormwater flows to their natural outlets, particularly for low-density development and residential subdivisions.

The use of natural open channels allows for more storage of stormwater flows on-site, lower stormwater peak flows, a reduction in erosive runoff velocities, infiltration of a portion of the runoff volume, and the capture and treatment of stormwater pollutants. It is critical that natural drainageways be protected from higher post-development flows by applying downstream channel protection methods (including the CP_v criteria) to prevent erosion and degradation.



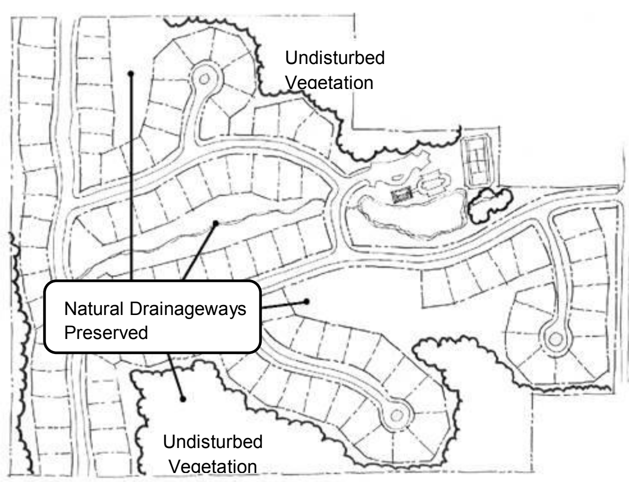


Figure 1.4.2-28 Example of a Subdivision Using Natural Drainageways for Stormwater Conveyance and Management

Better Site Design Practice #18:

Drain Runoff to Pervious Areas

Description: Where possible, direct runoff from impervious areas such as rooftops, roadways and parking lots to pervious areas, open channels or vegetated areas to provide for water quality treatment and infiltration. Avoid routing runoff directly to the structural stormwater conveyance system.

KEY BENEFITS

- Sending runoff to pervious vegetated areas increases overland flow time and reduces peak flows.
- Vegetated areas can often filter and infiltrate stormwater runoff.
- A stormwater site design credit can be taken if qualifies (see subsection 1.4.4).

USING THIS PRACTICE

☑ Minimize directly connected impervious areas and drain runoff as sheet flow to pervious vegetated areas.

Discussion

Stormwater quantity and quality benefits can be achieved by routing the runoff from impervious areas to pervious areas such as lawns, landscaping, filter strips and vegetated channels.

Much like the use of undisturbed buffers and natural areas (Better Site Design Practice #17), revegetated areas such as lawns and engineered filter strips and vegetated channels can act as biofilters for stormwater runoff and provide for infiltration in porous (hydrologic group A and B) soils. In this way, the runoff is “disconnected” from a hydraulically efficient structural conveyance such as a curb and gutter or storm drain system.

Some of the methods for disconnecting impervious areas include:

- Designing roof drains to flow to vegetated areas
- Directing flow from paved areas such as driveways to stabilized vegetated areas
- Breaking up flow directions from large paved surfaces (see Figure 1.4.2-31)
- Carefully locating impervious areas and grading landscaped areas to achieve sheet flow runoff to the vegetated pervious areas

For maximum benefit, runoff from impervious areas to vegetated areas must occur as sheet flow and vegetation must be stabilized. See Chapter 3 for more design information and specifications on filter strips and vegetated channels.

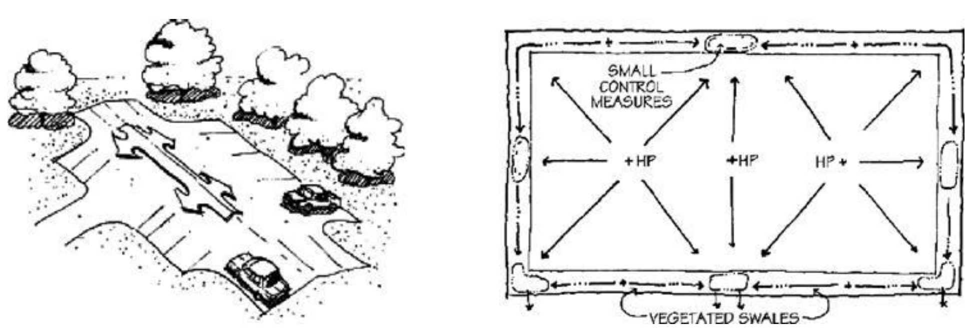


Figure 1.4.2-29 Design Paved Surfaces to Disperse Flow to Vegetated Areas

Source: NCDENR, 1998

1.4.3 Better Site Design Examples

1.4.3.1 Residential Subdivision Example 1

A typical residential subdivision design on a parcel is shown in Figure 1.4.3-1 (a). The entire parcel except for the subdivision amenity area (clubhouse and tennis courts) is used for lots. The entire site is cleared and mass graded, and no attempt is made to fit the road layout to the existing topography. Because of the clearing and grading, all of the existing tree cover and vegetation and topsoil are removed dramatically altering both the natural hydrology and drainage of the site. The wide residential streets create unnecessary impervious cover and a curb and gutter system that carries stormwater flows to the storm sewer system. No provision for non-structural stormwater treatment is provided on the subdivision site.

A residential subdivision employing stormwater better site design practices is presented in Figure 1.4.3-1 (b). This subdivision configuration preserves a quarter of the property as undisturbed open space and vegetation. The road layout is designed to fit the topography of the parcel, following the high points and ridgelines. The natural drainage patterns of the site are preserved and are utilized to provide natural stormwater treatment and conveyance. Narrower streets reduce impervious cover and grass channels provide for treatment and conveyance of roadway and driveway runoff. Landscaped islands at the ends of cul-de-sacs also reduce impervious cover and provide stormwater treatment functions. When constructing and building homes, only the building envelopes of the individual lots are cleared and graded, further preserving the natural hydrology of the site.

1.4.3.2 Residential Subdivision Example 2

Another typical residential subdivision design is shown in Figure 1.4.3-2 (a). Most of this site is cleared and mass graded, with the exception of a small riparian buffer along the large stream at the right boundary of the property. Almost no buffer was provided along the small stream that runs through the middle of the property. In fact, areas within the 100-year floodplain were cleared and filled for home sites. As is typical in many subdivision designs, this one has wide streets for on-street parking and large cul-de-sacs.

The better site design subdivision can be seen in Figure 1.4.3-2 (b). This subdivision layout was designed to conform to the natural terrain. The street pattern consists of a wider main thoroughfare that wind through the subdivision along the ridgeline. Narrower loop roads branch off of the main road and utilize landscaped islands. Large riparian buffers are preserved along both the small and large streams. The total undisturbed conservation area is close to one-third of the site.

1.4.3.3 Commercial Development Example

Figure 1.4.3-3 (a) shows a typical commercial development containing a supermarket, drugstore, smaller shops and a restaurant on an outlot. The majority of the parcel is a concentrated parking lot area. The only pervious area is a small replanted vegetation area acting as a buffer between the shopping center and adjacent land uses. Stormwater quality and quantity control are provided by a wet extended detention pond in the corner of the parcel.

A better site design commercial development can be seen in Figure 1.4.3-3 (b). Here the retail buildings are dispersed on the property, providing more of an “urban village” feel with pedestrian access between the buildings. The parking is broken up, and bioretention areas for stormwater treatment are built into parking lot islands. A large bioretention area which serves as open green space is located at the main entrance to the shopping center. A larger undisturbed buffer has been preserved on the site. Because of the bioretention areas and buffer provide water quality treatment, only a dry extended detention basin is needed for water quantity control.

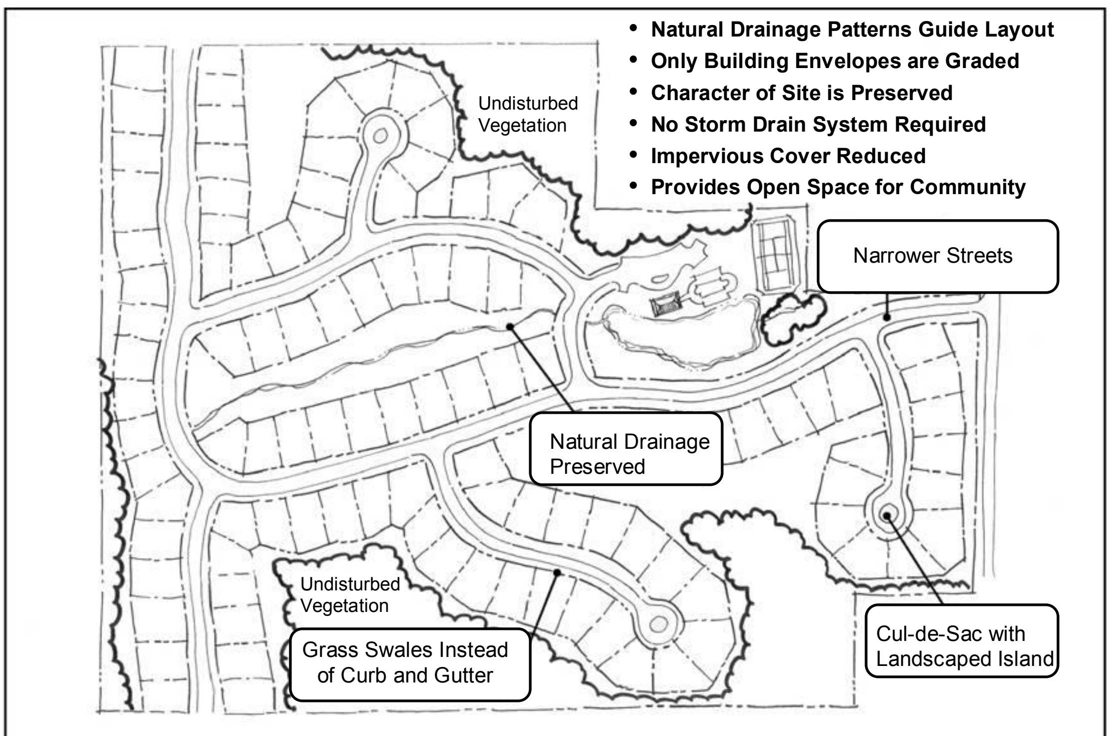
1.4.3.4 Office Park Example

An office park with a conventional design is shown in Figure 1.4.3-4 (a). Here the site has been graded to fit the building layout and parking area. All of the vegetated areas of this site are replanted areas.

The better site design layout, presented in Figure 1.4.3-4 (b), preserves undisturbed vegetated buffers and open space areas on the site. Both the parking areas and buildings have been designed to fit the natural terrain of the site. In addition, a modular porous paver system is used for the overflow parking areas.

Residential Subdivision #1 – Conventional Design

Figure 1.4.3-1 Comparison of a Traditional Residential Subdivision Design (above) with an Innovative Site Plan Developed Using Better Site Design Practices (below).

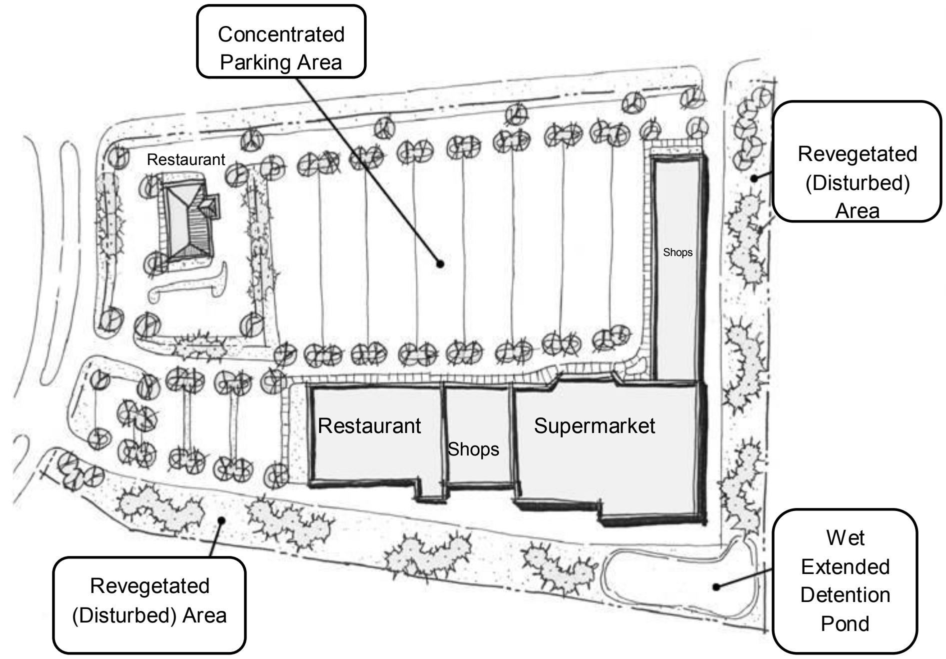


Residential Subdivision #1 – Better Site Design

Residential Subdivision #2 – Conventional Design

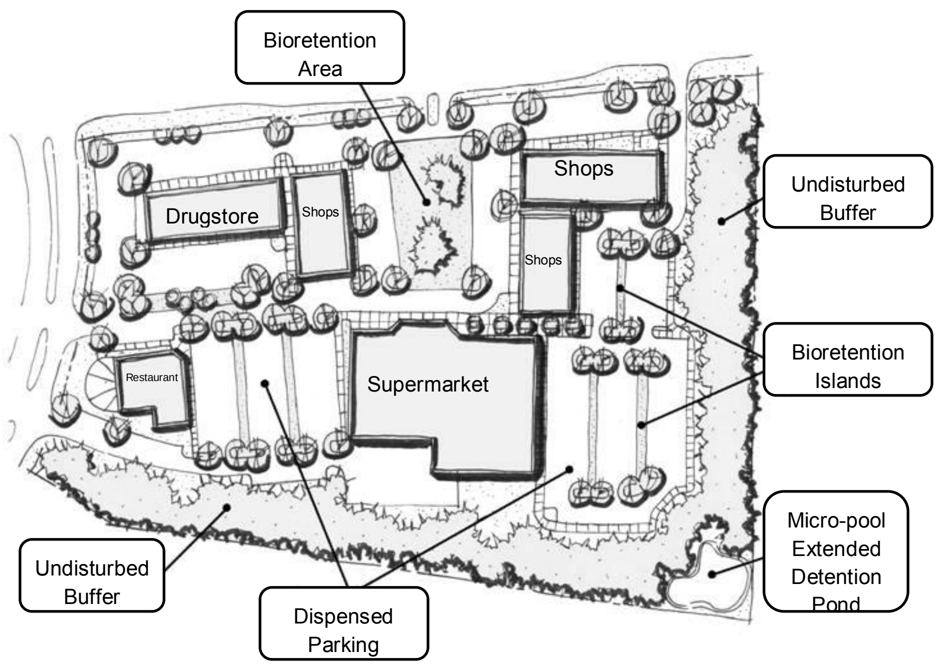
Figure 1.4.3-2 Comparison of a Traditional Residential Subdivision Design (above) with an Innovative Site Plan Developed Using Better Site Design Practices (below).

Residential Subdivision #2 – Better Site Design

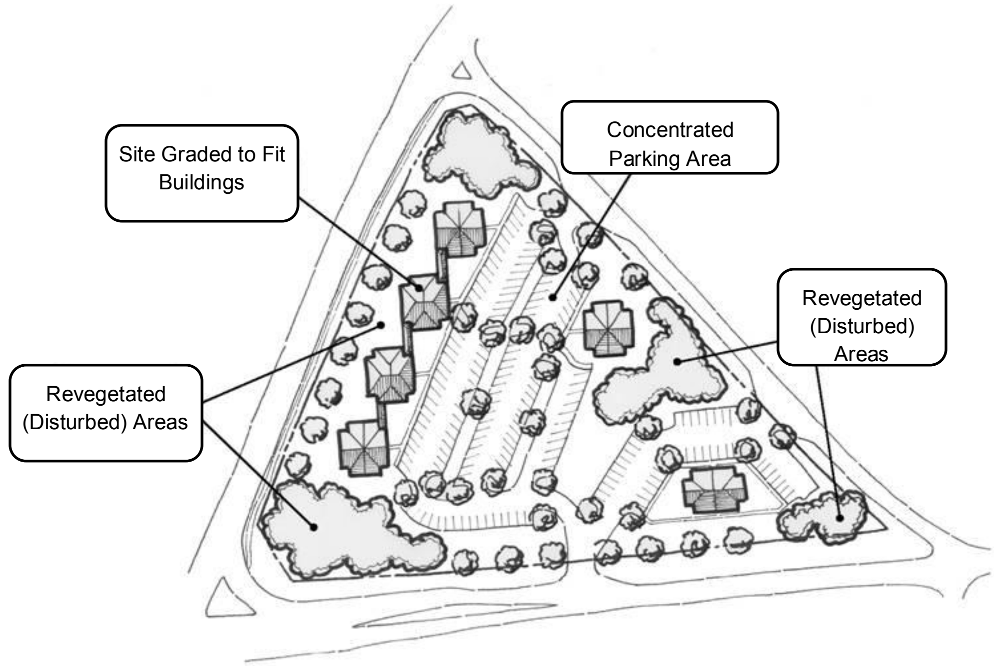


Commercial Development – Conventional Design

Figure 1.4.3-3 Comparison of a Traditional Commercial Development (above) with an Innovative Site Plan Developed Using Better Site Design Practices (below).

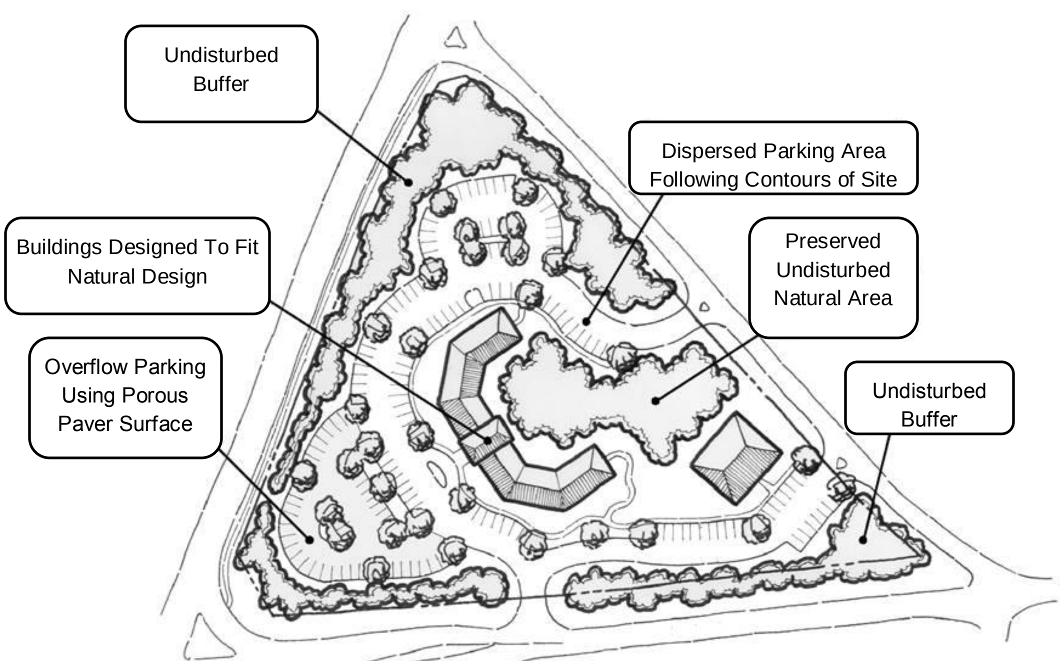


Commercial Development – Better Site Design



Office Park – Conventional Design

Figure 1.4.3-4 Comparison of a Traditional Office Park Design (above) with an Innovative Site Plan Developed Using Better Site Design Practices (below).



Office Park – Better Site Design

1.4.4 Site Design Stormwater Credits

1.4.4.1 Introduction

Non-structural stormwater control practices are increasingly recognized as a critical feature in every site design. As such, a set of stormwater “credits” has been developed to provide developers and site designers an incentive to implement better site design practices that can reduce the volume of stormwater runoff and minimize the pollutant loads from a site. The credit system directly translates into cost savings to the developer by reducing the size of structural stormwater control and conveyance facilities.

The basic premise of the credit system is to recognize the water quality benefits of certain site design practices by allowing for a reduction in the water quality treatment volume (WQ_v). If a developer incorporates one or more of the credited practices in the design of the site, the requirement for capture and treatment of the water quality volume will be reduced.

The better site design practices that provide stormwater credits are listed in Table 1.4.4-1. Site-specific conditions will determine the applicability of each credit. For example, stream buffer credits cannot be taken on upland sites that do not contain perennial or intermittent streams.

It should be noted that better site design practices and techniques that reduce the overall impervious area on a site already implicitly reduce the total amount of stormwater runoff generated by a site (and thus reduce WQ_v) and are not further credited under this system.

Table 1.4.4-1 Summary of Better Site Design Practices That Provide for Site Design Stormwater Credits

Practice	Description
Natural area conservation	Undisturbed natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics.
Stream buffers	Stormwater runoff is treated by directing sheet flow runoff through a naturally vegetated or forested buffer as overland flow.
Use of vegetated channels	Vegetated channels are used to provide stormwater treatment.
Overland flow filtration/infiltration zones	Overland flow filtration/infiltration zones are incorporated into the site design to receive runoff from rooftops and other small impervious areas.
Environmentally sensitive large lot subdivisions	A group of site design techniques are applied to low and very low density residential development.

For each potential credit, there is a minimum set of criteria and requirements which identify the conditions or circumstances under which the credit may be applied. The intent of the suggested numeric conditions (e.g., flow length, contributing area, etc.) is to avoid situations that could lead to a credit being granted without the corresponding reduction in pollution attributable to an effective site design modification.

Site designers are encouraged to utilize as many credits as they can on a site. Greater reductions in stormwater storage volumes can be achieved when many credits are combined (e.g., disconnecting rooftops and protecting natural conservation areas). However, credits cannot be claimed twice for an identical area of the site (e.g. claiming credit for stream buffers and disconnecting rooftops over the same site area).

Due to local safety codes, soil conditions, and topography, some of these site design credits may be restricted. Designers are encouraged to consult with the appropriate approval authority to ensure if and when a credit is applicable and to determine restrictions on non-structural strategies.

1.4.4.2 Stormwater Credits and the Site Planning Process

During the site planning process described in Section 1.5 there are several steps involved in site layout and design, each more clearly defining the location and function of the various components of the stormwater management system. The integration of site design credits can be integrated with this process as shown in Table 1.4.4-2.

Table 1.4.4-2 Integration of Site Design Credits with Site Development Process

Site Development Phase	Site Design Credit Activity
Feasibility Study	• Determine stormwater management requirements • Perform site reconnaissance to identify potential areas for and types of credits
Site Analysis	• Identify and delineate natural feature conservation areas (natural areas and stream buffers)
Concept Plan	• Preserve natural areas and stream buffers during site layout • Reduce impervious surface area through various techniques • Identify locations for use of vegetated channels and groundwater recharge • Look for areas to disconnect impervious surfaces • Document the use of site design credits.
Preliminary and Final Plan	• Perform layout and design of credit areas – integrating them into treatment trains • Ensure unified stormwater sizing criteria are satisfied • Ensure appropriate documentation of site design credits according to Columbia County requirements.
Construction	• Ensure protection of key areas • Ensure correct final construction of areas needed for credits
Final Inspection	• Develop maintenance requirements and documents • Ensure long term protection and maintenance • Ensure credit areas are identified on final plan and plat if applicable

1.4.4.3 Site Design Credit #1: Natural Area Conservation

A stormwater credit can be taken when undisturbed natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics. Under this credit, a designer would be able to subtract conservation areas from total site area when computing water quality volume requirements. An added benefit will be that the post-development peak discharges will be smaller, and hence water quantity control volumes (CP_v, Q_{p50}, and Q_f) will be reduced due to lower post-development curve numbers or rational formula “C” values.

Rule: Subtract conservation areas from total site area when computing water quality volume requirements.

Criteria:

- Conservation area cannot be disturbed during project construction
- Shall be protected by limits of disturbance clearly shown on all construction drawings
- Shall be located within an acceptable conservation easement instrument that ensures perpetual protection of the proposed area. The easement must clearly specify how the natural area vegetation shall be managed and boundaries will be marked [Note: managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management], and
- Shall have a minimum contiguous area requirement of 10,000 square feet
- R_v is kept constant when calculating WQ_v

Example:

Residential Subdivision

Area = 38 acres

Natural Conservation Area = 7 acres

Impervious Area = 13.8 acres

$$\mathbf{R_v = 0.05 + 0.009(I) = 0.05 + 0.009(36.3\%) = 0.37}$$

Credit:

7.0 acres in natural conservation area

New drainage area = 38 - 7 = 31 acres

Before credit:

$$\mathbf{WQ_v = (1.2)(0.37)(38)/12 = 1.40\ ac\text{-}ft}$$

With credit:

$$\mathbf{WQ_v = (1.2)(0.37)(31)/12 = 1.15\ ac\text{-}ft}$$

(18% reduction in water quality volume)

1.4.4.4 Site Design Credit #2: Stream Buffers

This credit can be taken when stormwater runoff is effectively treated by a stream buffer. Effective treatment constitutes treating runoff through overland flow in a naturally vegetated or forested buffer. Under the proposed credit, a designer would be able to subtract areas draining via overland flow to the buffer from total site area when computing water quality volume requirements. In addition, the volume of runoff draining to the buffer can be subtracted from the channel protection volume. The design of the stream buffer treatment system must use appropriate methods for conveying flows above the annual recurrence (1-yr storm) event.

Rule: Subtract areas draining via overland flow to the buffer from total site area when computing water quality volume requirements.

Criteria:

- The minimum undisturbed buffer width shall be 50 feet
- The maximum contributing length shall be 150 feet for pervious surfaces and 75 feet for impervious surfaces
- The average contributing slope shall be 3% maximum unless a flow spreader is used
- Runoff shall enter the buffer as overland sheet flow. A flow spreader can be supplied to ensure this, or if average contributing slope criteria cannot be met
- Not applicable if overland flow filtration/groundwater recharge credit is already being taken
- Buffers shall remain unmanaged other than routine debris removal
- R_v is kept constant when calculating WQ_v

Example:

Residential Subdivision

Area = 38 acres

Impervious Area = 13.8 acres

Area Draining to Buffer = 5 acres

$$\mathbf{R_V = 0.05 + 0.009(I) = 0.05 + 0.009(36.3\%) = 0.37}$$

Credit:

5.0 acres draining to buffer

New drainage area = 38 - 5 = 33 acres

Before credit:

$$\mathbf{WQ_V = (1.2)(0.37)(38)/12 = 1.40\ ac\text{-}ft}$$

With credit:

$$\mathbf{WQ_V = (1.2)(0.37)(33)/12 = 1.22\ ac\text{-}ft}$$

(13% reduction in water quality volume)

1.4.4.5 Site Design Credit #3: Vegetated Channels

This credit may be taken when vegetated (grass) channels are used for water quality treatment. Under the proposed credit, a designer would be able to subtract the areas draining to a grass channel from total site area when computing water quality volume requirements. A vegetated channel can fully meet the water quality volume requirements for certain kinds of low-density residential development (see low impact development credit). An added benefit will be that the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

This credit <u>cannot</u> be taken if grass channels are being used as a limited application structural stormwater control towards meeting the 80% TSS removal goal for WQ_v treatment.

Rule: Subtract the areas draining to a grass channel from total site area when computing water quality volume requirements.

Criteria:

- The credit shall only be applied to moderate or low density residential land uses (3 dwelling units per acre maximum)
- The maximum flow velocity for water quality design storm shall be less than or equal to 1.0 feet per second
- The minimum residence time for the water quality storm shall be 5 minutes
- The bottom width shall be a maximum of 6 feet. If a larger channel is needed use of a compound cross section is required
- The side slopes shall be 3:1 (horizontal:vertical) or flatter
- The channel slope shall be 3 percent or less
- R_v is kept constant when calculating WQ_v

Example:

Residential Subdivision

Area = 38 acres

Impervious Area = 13.8 acres

$$\mathbf{R_V = 0.05 + 0.009(I) = 0.05 + 0.009(36.3\%) = 0.37}$$

Credit:

12.5 acres meet grass channel criteria

New drainage area = 38 - 12.5 = 25.5 acres

Before credit:

$$\mathbf{WQ_V = (1.2)(0.37)(38)/12 = 1.40\ ac\text{-}ft}$$

With credit:

$$\mathbf{WQ_V = (1.2)(0.37)(25.5)/12 = 0.94\ ac\text{-}ft}$$

(33% reduction in water quality volume)

1.4.4.6 Site Design Credit #4: Overland Flow Filtration/Groundwater Recharge Zones

This credit can be taken when “overland flow filtration/infiltration zones” are incorporated into the site design to receive runoff from rooftops or other small impervious areas (e.g., driveways, small parking lots, etc). This can be achieved by grading the site to promote overland vegetative filtering or by providing infiltration or “rain garden” areas. If impervious areas are adequately disconnected, they can be deducted from total site area when computing the water quality volume requirements. An added benefit will be that the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

Rule: If impervious areas are adequately disconnected, they can be deducted from total site area when computing the water quality volume requirements.

Criteria:

- Relatively permeable soils (hydrologic soil groups A and B) should be present
- Runoff shall not come from a designated hotspot
- The maximum contributing impervious flow path length shall be 75 feet
- Downspouts shall be at least 10 feet away from the nearest impervious surface to discourage “re-connections”
- The disconnection shall drain continuously through a vegetated channel, swale, or filter strip to the property line or structural stormwater control
- The length of the “disconnection” shall be equal to or greater than the contributing length
- The entire vegetative “disconnection” shall be on a slope less than or equal to 3 percent
- The surface imperviousness area to any one discharge location shall not exceed 5,000 square feet
- For those areas draining directly to a buffer, either the overland flow filtration credit *-or-* the stream buffer credit can be used
- R_v is kept constant when calculating WQ_v

Example:

Site Area = 3.0

Impervious Area = 1.9 acres (or 63.3% impervious cover)

“Disconnected” Impervious Area = 0.5 acres

$$\mathbf{R_V = 0.05 + 0.009(I) = 0.05 + 0.009(63.3\%) = 0.62}$$

Credit:

0.5 acres of surface imperviousness hydrologically disconnected

New drainage area = 3 – 0.5 = 2.5 acres

Before credit:

$$\mathbf{WQ_V = (1.2)(0.62)(3)/12 = 0.19\ ac\text{-}ft}$$

With credit:

$$\mathbf{WQ_V = (1.2)(0.62)(2.5)/12 = 0.15\ ac\text{-}ft}$$

(21% reduction in water quality volume)

1.4.4.7 Site Design Credit #5: Environmentally Sensitive Large Lot Subdivisions

This credit can be taken when a group of environmental site design techniques are applied to low and very low density residential development (e.g., 1 dwelling unit per 2 acres [du/ac] or lower). The credit can eliminate the need for structural stormwater controls to treat water quality volume requirements. This credit is targeted towards large lot subdivisions and will likely have limited application.

Rule: Targeted towards large lot subdivisions (e.g. 2.5 acre lots and greater). The requirement for structural practices to treat the water quality volume treatment requirements shall be waived.

<u>Criteria:</u>

For Single Lot Development:

- Total site impervious cover is less than 15%
- Lot size shall be at least two acres
- Rooftop runoff is disconnected in accordance with the criteria in Credit #4
- Grass channels are used to convey runoff versus curb and gutter

For Multiple Lots:

- Total impervious cover footprint shall be less than 15% of the area
- Lot areas should be at least 2.5 acres, unless clustering is implemented. Open space developments should have a minimum of 25% of the site protected as natural conservation areas and shall be at least a half-acre average individual lot size
- Grass channels should be used to convey runoff versus curb and gutter (see Credit #3)
- Overland flow filtration/infiltration zones should be established (see Credit #4)

This page left intentionally blank.